

PB83-173138

Computer-Assisted Procedure for the Design and
Evaluation of Wastewater Treatment Systems
(CAPDET) - Programmer's Reference Manual

(U.S.) Office of the Chief of Engineers (Army)
Washington, DC

1982



U.S. Department of Commerce
National Technical Information Service
NTIS

"Working Draft"

PB83-173138

PROGRAMMER'S REFERENCE MANUAL

COMPUTER-ASSISTED PROCEDURE
FOR
THE DESIGN AND EVALUATION
OF
WASTEWATER TREATMENT SYSTEMS (CAPDET)

Department of the Army
Corps of Engineers
Office of the Chief of Engineers

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TABLE OF CONTENTS

	Subject	Paragraph	Page
CHAPTER 1	INTRODUCTION		
	Purpose	1-1	1
	Applicability	1-2	1
	References	1-3	1
	Scope	1-4	1
CHAPTER 2	THE EXECUTIVE ROUTINE		
	General	2-1	3
	Unit Process Subroutine Names	2-2	7
	Unit Process Data Bank	2-3	16
	Unit Process Data Input	2-4	19
	Pseudo Treatment Processes	2-5	23
	Treatment Process Modifications	2-6	23
	Treatment Scheme Input	2-7	24
	Train Identification Algorithm	2-8	31
	Waste Stream and Desired		
	Effluent Data Input	2-9	33
	Unit Cost Data Input	2-10	34
	Program Control Card Input	2-11	41
CHAPTER 3	SUBROUTINE PROCES		
	General	3-1	44
	Cost Estimating Routines	3-2	44
	Pseudo Processes	3-3	48
	Treatment Process - Unit Process		
	Relationship	3-4	48
	Train Save Table	3-5	49
	Small Facilities	3-6	52
	Anaerobic Digester Supernatant	3-7	52
CHAPTER 4	SUBROUTINE FIGURE		
	General	4-1	53
	FIGURE Subroutine Arguments	4-2	53
	Common SUMMCO	4-3	53
	Unit Process Identification	4-4	55
	Labor Rates	4-5	59
	Cost Summary Output	4-6	60

BIBLIOGRAPHIC INFORMATION

PB83-173138

Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET) - Programmer's Reference Manual.

1982

PERFORMER: Office of the Chief of Engineers (Army).
Washington, DC.

See also PB83-148486.

This manual describes the documentation of the FORTRAN Programming of the May 31, 1980 version of the CAPDET system. The documentation is intended for use by persons responsible for the maintenance of the program, its updating, or its implementation on other computing systems. The assumption has been made that the reader is a competent FORTRAN programmer and is familiar with the CAPDET User's Guide.

KEYWORDS: *Sewage treatment, *Programming manuals, *Waste water, *Computer aided design.

Available from the National Technical Information Service,
Springfield, Va. 22161

PRICE CODE: PC A06/MF A01

ATTENTION

AS NOTED IN THE NTIS ANNOUNCEMENT,
PORTIONS OF THIS REPORT ARE NOT LEGIBLE.
HOWEVER, IT IS THE BEST REPRODUCTION
AVAILABLE FROM THE COPY SENT TO NTIS.

TABLE OF CONTENTS (Continued)

	Subject	Paragraph	Page
CHAPTER 5	SUBROUTINE BLOCKDATA		
	General	5-1	62
	Unit Process Design		
	Specifications	5-2	62
	Influent Waste Characteristics	5-3	64
	Unit Cost Data	5-4	65
	Large and Small System Unit		
	Process Data Addresses	5-5	65
CHAPTER 6	ADDING PROCESSES		
	General	6-1	67
	New Routine Addition	6-2	67
	Large System Unit Process		
	Addition	6-3	70
	Small System Unit Process		
	Addition	6-4	78
APPENDIX A	EXECUTIVE ROUTINE FLOWCHART		
APPENDIX B	SUBROUTINE PROCES FLOWCHART		
APPENDIX C	GLOSSARY OF VARIABLES IN THE EXECUTIVE ROUTINE (CAPDET)		

LIST OF FIGURES

Figure Number	Title	Page
1	Subroutine CALL Structure	4
2	Data Address Pointer System	17
3	Unit Process Input Scheme	21
4	Unit Process Input Subroutine	22
5	Internal Representation of a Treatment Scheme	25
6	Treatment Train Selection System	32
7	Subroutine Organization in Processes Developed Prior to 1978	46
8	Subroutine Structure for Processes Developed After 1978	47
9	Independent Unit Process Data Interface	50
10	Dependant Unit Process Data Interface	51

CHAPTER 1

INTRODUCTION

1-1 Purpose. This manual describes the documentation of the FORTRAN Programming of the May 31, 1980 version of the CAPDET system. The documentation is intended for use by persons responsible for the maintenance of the program, its updating, or its implementation on other computing systems. The assumption has been made that the reader is a competent FORTRAN programmer and is familiar with the CAPDET User's Guide.

1-2 Applicability. The provisions of this documentation are applicable to Corps of Engineers Districts and Divisions concerned with the maintenance and operation of the CAPDET program.

1-3 References. In addition to this manual, documentation for the CAPDET system consists of:

- a. EM 1110-2-501 Part I, Design of Wastewater Treatment Facilities.
- b. EM 1110-2-501 Part II, (Draft), Design of Small Systems Wastewater Treatment Facilities.
- c. Computer Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET) User's Guide.
- d. EPA 430/9-77-013, MCD-37, Construction Costs for Municipal Wastewater Treatment Plants: 1973-1977.
- e. CAPDET Task II Report, Clark-Dietz Engineers, Inc., 1978.
- f. A listing of the FORTRAN source code for the CAPDET program.

1-4 Scope.

a. This programmer's reference contains sufficient documentation to illustrate the algorithms used in the CAPDET program. CAPDET is driven by an executive routine which maintains overall control and direction of the system. Evaluation and design of a particular treatment train

is controlled by subroutine PROCES. The complete cost summary of each train is provided by subroutine FIGURE. There are input, output, and execution routines for each of the unit processes included in the system. Default data for CAPDET is included in subroutine BLOCKDATA. Descriptions and flow charts will be presented for the four major routines. Detailed documentation of each of the subroutines associated with the unit processes would be highly repetitive thus only examples of the interface between these routines and the three controlling routines will be provided.

b. The current structure of CAPDET allows for three (3) modifications of 80 liquid unit processes and 20 sludge unit processes. Of these only 57 liquid and 14 sludge unit processes have been implemented for large systems. For small systems, there are 23 liquid and three (3) sludge unit processes. The changes necessary to add other processes to the system will be illustrated.

c. A list of variable names used in the controlling routines, along with their meanings and units will be presented.

d. The technique for storing standard or default data for the various unit processes will be illustrated.

e. The algorithms associated with the individual process routines are illustrated in EM 110-2-501 Parts I and II, and will not be repeated here. The variable names used in the program are closely associated with the names used in the Design Manual.

f. The unit cost algorithms and the variable names used in the program are documented in the CAPDET Task II report.

CHAPTER 2

THE EXECUTIVE ROUTINE

2-1 General. The executive routine for CAPDET may be broken functionally into the following subdivisions.

- a. Small System Selection Input
- b. Unit Process Data Input
- c. Treatment Scheme Input
- d. Waste Stream Data Input
- e. Desired Effluent Data Input
- f. Unit Cost Data Input
- g. Process Execution, Evaluation, and Output

Figure 1 illustrates the overall subroutine CALL structure from the executive routine CAPDET. Subroutine SCAN is the general routine which allows the user to input numerical data in free format. This routine is used for all data input with the exception of the treatment scheme description input.

The user will initially input the unit process specifications. For modification zero (0) of each unit process, default data are preloaded and only the data items to be changed will be input. A more detailed discussion of the CAPDET unit process default data base will be presented in sections 2-6 and 3-2.

EXECUTIVE ROUTINE

SCAN

Unit
Process
Input
Routines

INIT

SCAN

WASTIN

DESIIN

UNITIN

Unit
Process
Execution
Routines

INIT

PRICE

PROCES

Unit Process
Estimate
Costing

Unit
Process
Output
Routine

INIT

Unit Process
Quantity
Output

FIGURE

Figure 1. Subroutine CALL Structure

After the unit process specifications have been input the user inputs a TITLE card and the treatment scheme alternatives. These inputs are accomplished in the executive routine. A more detailed discussion of the treatment scheme input will be presented in section 2-7.

The user will then input the characteristics of the influent waste stream using subroutine WASTIN. All of the influent characteristics with the exception of average, minimum, and maximum flows have preloaded default values. A more detailed discussion of the waste influent stream input and default data base will be presented in sections 2-8 and 3-3.

The desired effluent characteristics are input using subroutine DESIIN immediately after the influent characteristics. There are no default values for the effluent characteristics. Only those waste stream characteristics input will be checked to determine if the respective train will satisfy the effluent requirements. A more detailed discussion of DESIIN is presented in section 2-8.

Following the desired effluent input, the user will input the unit cost data using subroutine UNITIN. Each of the unit cost data items are preloaded with default data so that the user only inputs the data items he wishes to change. A more detailed discussion of the unit cost input and the unit cost default data base is presented in sections 2-10 and 3-4.

The user will then input the program output control cards. These control cards are presented in more detail in section 2-11. The final control card is the 'GO' card which provides the interest rate and the design life of the treatment plant and signals the system to begin the execution of the particular run.

Subroutine PROCES begins the execution of each treatment train by calling the execution routines of the unit processes which comprise each successive treatment process. The characteristics of the waste stream are altered to reflect the treatment by each of the unit processes and the effluent of the overall treatment process becomes the influent for the subsequent treatment process. For those unit processes which have estimate costing implemented, an estimate costing routine is called. In those unit processes for which estimate costing has not been implemented, the routine PRICE is called to determine the cost of the unit process parametrically. A more detailed discussion of the unit process execution routines is presented in chapter 3.

When each treatment train has been processed, subroutine FIGURE is called to output the cost summary of the train. A schematic of the treatment processes included in the train and a cost summary of each unit process is output. In addition, total construction cost, direct and indirect construction costs, miscellaneous costs, and the economic evaluation (equivalent annual cost, annual operation and maintenance cost, and present worth cost) costs are output. A more detailed discussion of the cost summary output is presented in section 4-6.

2-2 Unit Process Subroutine Names. Each unit process has associated with it a four-character acronym which is used to identify its three primary subroutines. The three primary subroutines accomplish input, execution, and output for the unit process. The primary subroutines are named by appending the characters 'IN', 'EX', or 'OT' to the acronym. For those unit processes that had been developed prior to 1978, estimate costing was implemented by adding two additional subroutines. These two subroutines provide for the pricing and quantity output for the unit process. The subroutines are named by appending the characters 'PR' and 'QU' to the unit process acronym. For those unit processes implemented in CAPDET after 1978, these functions have been included in the execution and output routines. Also associated with each unit process is an internal unit process number. For each unit process included in the CAPDET large and small systems, the internal unit process numbers, the acronyms and the functions of the unit processes are given below along with the keywords describing the treatment processes which use them. The internal treatment process number is given in parentheses following the treatment process keyword. For the small system unit processes which are not duplicates of large system unit processes (BANKDA data address 1688 or above), the unit process acronym is preceded with a 'Z' and is appended with either an 'I', 'O', or 'X' for the input, output, or execution routines, respectively. For example, the small system Flotation unit process routines are ZFLOTI, ZFLOTO, and ZFLOTX.

Large System Unit Processes

Internal Process Number	Process Acronym	Unit Process Description	Number of Data Items	BANKDA Data Address	Number of ID	ID Address	FIGURE Output Number	Treatment Process Keyword
Sludge Line Unit Processes								
1	SLFL	Sludge Flotation	21	1438	6	320	81	SLUD (1)
2	AERO	Anaerobic Digestion	25	1459	7	326	82	AERO (2)
3	ANAE	Anaerobic Digestion	35	1484	4	333	83	ANAE (3)
4	THIC	Gravity Thickening	17	1519	4	337	84	GRAV (4)
5	VACU	Vacuum Filtration	18	1536	7	341	85	VACU (5)
6	CENT	Centrifugation	16	1554	6	348	86	CENT (6)
7	DRYI	Drying Beds	19	1570	2	354	87	DRYI (7)
8	HAUL	Hauling and Land Filling	13	1589	4	356	88	HAUL (12)
9	MIIN	Multiple Hearth Incineration	14	1602	1	360	89	HULT (13)
10	FBIN	Fluidized Bed Incineration	41	1616	10	361	90	FLUI (14)
11	PRES	Filter Press	11	1657	-	-	91	FLTR (15)
12	PFIL	Pressure Filtration	8	1668	-	-	92	PRES (16)
13	WET	Wet Oxidation	12	1676	-	-	93	WET (17)
14	SLUH	User Specified Sludge Process	6	-	-	-	95	USER (18)

Internal Process Number	Process Acronym	Unit Process Description	Number of Data Items	BANKDA Data Address	Number of ID	ID Address	FIGURE Output Number	Treatment Process Keyword
Liquid Unit Processes								
1	EQU	Equalization	56	1	7	1	1	EQUA (1)
2	FLOT	Flotation	24	57	6	8	2	FLOT (2)
3	FILT	Filtration	81	81	7	14	3	FILT (3)
4	HICR	Microscreening	22	162	1	21	4	HICR (4)
5	CARB	Carbon Adsorption	51	184	8	22	5	CARBO (5)
6	COUN	Counter Current Ammonia Stripping	12	235	-	-	6	COUN (6)
7	CROS	Cross Current Ammonia Stripping	12	247	-	-	7	CROS (7)
8	CION	Cation	28	259	-	-	8	CATI (8)
9	AION	Anion Exchange	28	287	-	-	9	ANIO (9)
10	NEUT	Neutralization	7	315	-	-	10	NEUT (10)
11	DISI	Chlorination	9	322	-	-	11	CHLO (11)
12	TRIC	Trickling Filtration	35	331	3	31	12	TRIC (12)
13	CHAS	Complete Mix Activated Sludge	36	366	11	34	13	COMP (13)
14	STEP	Step Aeration Activated Sludge	36	402	11	45	14	STEP (14)

Internal Process Number	Process Acronym	Unit Process Description	Number of Data Items	BANKDA Data Address	Number of ID	ID Address	FIGURE Output Number	Treatment Process Keyword
15	PLUG	Plug Flow	36	483	11	56	15	PLUG (15)
16	HIGH	High Rate Activated Sludge	36	474	10	67	16	HIGH (16)
17	PURE	Pure Oxygen Activated Sludge	36	510	11	77	17	PURE ₁ (17)
18	EXTE	Extended Aeration Activated Sludge	37	546	11	88	18	EXTE (18)
19	CONT	Contact Stabilization Activated Sludge	32	583	5	99	19	CONT (19)
20	LAGO	Lagoon	21	1764	4	387	20	LAGO (20)
21	CHAL	Completely Mixed Aerated Lagoon	31	622	10	104	21	AERA (21)
22	Not Used							
23	OXID	Oxidation Ditch	32	653	11	114	23	OXID (23)
24	NITR	Suspended Growth Nitrification	29	685	8	125	24	NITR (24)
25	COAG	Coagulation	14	714	4	133	60	COAG (25)
26	PRIM	Primary Clarification	24	728	9	137	26	PRIM (26)
27	GRIT	Grit Removal	25	752	11	146	61	PREL (27)
28	SCRN	Screening	13	777	7	157	-	PREL (27)
29	COMM	Comminution	5	790	1	164	-	PREL (27)

Internal Process Number	Process Acronym	Unit Process Description	Number of Data Items	BANK/DA Data Address	Number of ID	ID Address	FIGURE Output Number	Treatment Process Keyword
30	Not Used							
31	SECO	Secondary Clarifier Activated Sludge	23	795	4	165	31	COMP (13) STEP (14) PLUG (15) HIGH (16) EXTE (18) CONT (19)
32	CLAR	Secondary Clarifier Nitrification	24	818	4	169	32	NITR (24)
33	XECO	Secondary Clarifier Trickling Filter	24	842	4	173	33	TRIC (12)
34	DENI	Suspended Growth Denitrification	51	866	10	177	34	DENI (28)
35	DUMH	Dummy Process	30	-	-	-	35	DUMH (30)
36	POST	Post Aeration	38	917	6	187	36	POST (31)
37	RBC	Rotating Biological Contactor	29	955	2	193	37	RBC (32)
38	RECA	Recarbonation	5	984	-	-	38	RECA (34)
39	FLOG	Flocculation	7	989	-	-	39	TWO (35)

Internal Process Number	Process Acronym	Unit Process Description	Number of Data Items	BANKDA Data Address	Number of ID	ID Address	FIGURE Output Number	Treatment Process Keyword
40	LRIM	Primary Clarifier Lime Treatment	24	996	9	195	40	TWO (35)
41	FREC	First Stage Lime Treatment	5	1020	-	-	41	TWO (35)
42	SREC	Second Stage Lime Treatment	5	1025	-	-	42	TWO (35)
43	OVER	Overland Flow Land Treatment	65	1030	28	204	43	OVER (36)
44	RAPI	Rapid Infiltration Land Treatment	66	1095	26	232	44	RAPI (37)
45	SLOW	Slow Infiltration Land Treatment	67	1161	28	258	45	SLOW (38)
46	Not Used							
47	Not Used							
48	Not Used							
49	PUMP	Pumping	4	2025	3	423	53	PUMP (42)
50	PECO	Secondary Clarifier Pure Oxygen	23	1230	4	286	49	PURE (17)
51	OECO	Secondary Clarifier Oxidation Ditch	23	1253	4	290	50	OXID (23)
52	RECO	Secondary Clarifier RBC	23	1276	4	294	54	RBC (32)

Internal Process Number	Process Acronym	Unit Process Description	Number of Data Items	BANKDA Data Address	Number of ID	ID Address	FIGURE Output Number	Treatment Process Keyword
53	DLAR	Secondary Clarifier Denitrification (SG)	24	1299	4	298	62	DENI (28)
54	DATT	Attached Growth Denitrification	34	1323	8	302	63	ATTA (33)
55	NRBC	Nitrification RBC	16	1357	2	310	64	N RB (43)
56	NTRF	Nitrification Trickling Filter	27	1373	4	312	65	N TR (44)
57	RAWS	Raw Sewage Pumping	38	1400	4	316	66	RAW (22)

Small System Unit Processes

Internal Process Number	Process Acronym	Unit Process Description	Number of Data Items	BANKDA Data Address	Number of ID	ID Address	FIGURE Output Number	Treatment Process Keyword
Sludge Line Unit Processes								
1	SLUD	Sludge Drying Lagoons	17	1990	2	419	94	SLUD (1)
7	DRYI	Drying Beds	18	2007	1	421	87	DRYI (7)

Internal Process Number	Process Acronym	Unit Process Description	Number of Data Items	BANKDA Data Address	Number of ID	ID Address	FIGURE Output Number	Treatment Process Keyword
Liquid Unit Processes								
1	EQU	Equalization	56	1	7	1	1	EQUA (1)
2	FLOT	Flotation	33	1688	7	371	2	FLOT (2)
3	FILT	Filtration	19	1721	4	378	3	FILT (3)
4-10	Not Used							
11	CHLO	Chlorination	24	1740	5	382	11	CHLO (11)
12	TRIC	Trickling Filter	35	331	3	31	12	TRIC (12)
13-19	Not Used							
20	LAGO	Lagoon	21	1764	4	387	20	LAGO 920)
21	AERA	Aerated Lagoon	48	1785	8	391	21	AERA (21)
22	Not Used							
23	OXID	Oxidation Ditch	36	1833	4	399	23	OXID (23)
24	Not Used							
25	COAG	Coagulation	27	1869	4	403	25	COAG (25)
26	PRIM	Primary Clarification	24	728	9	137	26	PRIM (26)
27	Not Used							
28	BAR	Bar Screens	19	1896	4	407	27	PREL. (27)

Internal Process Number	Process Acronym	Unit Process Description	Number of Data Items	BANKDA Data Address	Number of ID	ID Address	FIGURE Output Number	Treatment Process Keyword
29-34	Not Used							
35	DURH	Dummy	30	-	-	-	35	DURH (30)
36	POST	Post Aeration	38	917	6	187	36	POST (31)
3-42	Not Used							
43	OVER	Overland Flow Land Treatment	65	1030	28	204	43	OVER (36)
44	RAPI	Rapid Infiltration Land Treatment	66	1095	26	232	44	RAPI (37)
45	SLOW	Slow Infiltration Land Treatment	67	1161	28	258	45	SLOW (38)
46	SEPT	Septic Tank	14	1915	1	411	46	SEPT (39)
47	ACTI	Activated Sludge	24	1929	3	412	47	ACTI (40)
48	INTE	Intermittent Sand Filter	23	1953	3	415	48	INTE (41)
49	PUMP	Pumping	4	2025	3	423	53	PUMP (42)
50-56	Not Used							
57	RAW	Raw Sewage Pumping	14	1976	1	418	66	RAW (22)

2-3 Unit Process Data Bank. Data for the various unit processes are stored in the variable BANKDA in named common BANKCO. The locations of the default data for modification zero (0) of each large and small system unit process are shown in the previous table of unit processes. For each unit process, the BANKDA process address is the first address for the default data of the respective unit process. Modifications one (1) and two (2) of each unit process have no default data, and the location of the data for these two modifications of a process will depend upon the order in which the input data were read. Four tables of address pointers contain the beginning address for each set of data. For large facilities, these tables are LQADD for liquid unit processes and LSADD for sludge unit process. For small facilities these tables are LQADS for liquid unit processes and LSADS for sludge unit processes. The address of the first unused location in BANKDA is stored in the variable NEXTAD. The number of words of data associated with each unit process is indicated in table NOQ for liquid, or NOS for sludge unit processes. The values of NOS and NOQ specified in the executive routine are for large facilities while the values for small facilities are specified in SMALIN. An illustration of this pointer system is shown in Figure 2.

The above data bank arrangement allows the unit process sub-routines to operate with sets of variables for the various modifications simply by moving the pointer indicating the beginning of the

Internal
Liquid
Unit
Process
Number

Liquid
Unit
Process
Keywords
LISQ(80)

Liquid Process
Address Pointers
LQADD(80,3)

Number
Of
Data
Items
NOQ(80)

COMMON/BANKCO/BANKDA(300

1
2
3
4
5

78
79
80

EQUALI
FLOTAT
FILTRA
MICROS
CARBON

56
24
81
22
51

MOD MOD MOD
0 .1 2

Internal
Sludge
Unit
Process
Number

Sludge
Unit
Process
Keywords
LISS(20)

Sludge Process
Address Pointers
LSADD(20,3)

Number
Of
Data
Items
NOS(20)

1
2
3
4
5

19
20

SLUDGE
AEROBI
ANAERO
GRAVIT
VACUUM

21
25
35
17
18

MOD MOD MOD
0 1 2

NETAD

Figure 2. Data Address Pointer System

data set. The data address is passed as an argument in the subroutine call. For example

```
KADD = LQADD (20,1)
CALL ZLAGOI (BANKDA(KADD),ID(1,387),MODT)
```

Since the dummy argument in the subroutine statement cannot be used in an EQUIVALENCE statement, the data are moved from BANKDA to another dimensioned array, QQ. Positions in this array are then equivalenced to the desired variable names. Prior to returning to the calling routine, the data must be moved back to BANKDA. Both of these data transfers are made by calling subroutine INIT. An example of the typical input routine structure is shown below. The dimensioned array RR is loaded with the BANKDA data beginning at the specified address KADD (1764 for Lagoons). The dimensioned array QQ is equivalenced to the 21 data parameters associated with the lagoon unit process. The subroutine INIT is called to simply transfer 21 items from array RR (BANKDA) to the array QQ. After the routine is executed, and immediately before the RETURN, subroutine INIT is called a second time to transfer the 21 data items from array QQ back to array RR (BANKDA).

```

SUBROUTINE ZLAGOI (RR,ID,MODT)
DIMENSION ID (3,1),RR(1),LIST(8),KLM(74),VALUE(10),
COMMON/QQCO/QQ(168)
EQUIVALENCE(QQ(1),DC ),(QQ(2),FLBOD),(QQ(3),D),
>(QQ(4),XOSTSP),(QQ(5),COSLI),(QQ(6),ITYP),
>(QQ(7),SA),(QQ(8),V),(QQ(9),DT),(QQ(10),CSA),
>(QQ(11),NLC),(QQ(12),FL),(QQ(13),VLEW),(QQ(14),ALL),
>(QQ(15),DLA),(QQ(16),FLDLA),(QQ(17),(NBV),(QQ(18),XOSTSV),
>(QQ(19),VCW),(QQ(20),VCS),(QQ(21),OMMH)
.
.
.
CALL INIT (QQ, RR, 21)
.
.
.
      (subroutine execution)
.
.
CALL INIT (RR, QQ, 21)
RETURN
END

```

2-4 Unit Process Data Input. The first four characters of the unit process header cards constitute keywords which are used to select the input subroutine for reading the unit process data cards. The modification number (if not blank or zero) is also given on this card. Having determined which unit process input routine is to be used, the program then checks the data address pointer table to determine if a data area has been established for this modification of the process. If no data area has been established, the address is set at the next available location, NEXTAD, in BANKDA and NEXTAD is increased by the number of words reserved for this process as indicated by table NOQ or NOS. This means that data input for a particular modification of a unit process can be accomplished in different parts, and, also more importantly, this allows default data to be stored in the program for modification zero (0) of each unit process. These default data may then be overridden with input cards.

Once the data address of the process is established, a call is made to the input subroutine passing the beginning data address of the process. So that unique variable names may be used, the unit process routine will move its data from BANKDA to an array which has been equivalenced to the proper variable names.

The first four characters of each input data card contains a keyword which identifies the data on that card. Subroutine SCAN is used to determine the numeric values on the card and these values are then assigned to the proper variable name.

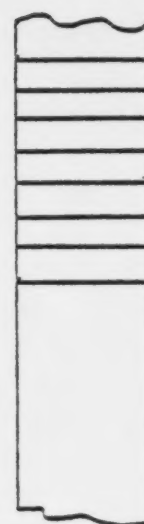
Each unit process input subroutine is terminated when the sentinel card for its data, the END card, is read. Prior to returning to the executive routine, the input routine will move the equivalenced array data back into BANKDA.

Figures 3 and 4 illustrate this input system and show examples of the pertinent FORTRAN code. Figure 3 illustrates the internal management of the data bank system for a modification one (1) lagoon unit process data input. Note that modification zero (0) of the lagoon is already loaded with default data as indicated by the beginning address of 1764 in BANKDA. As indicated by the code from the CAPDET executive routine, the next available address in BANKDA is 2029 (NEXTAD). At statement number 7021, LQADD for the modification one (1) is initially 0, and NEXTAD is loaded into LQADD (20,2). Then NEXTAD is incremented by NOQ (20) which is 21. Also note that if modification zero (0) is called that at statement number 7021 control is passed immediately to statement number 602 and the variables LQADD and NEXTAD are not changed. Figure 4 illustrates the input of the characteristics of the lagoon by the ZLAGOI subroutine.

LAGOON MOD 1
 DEPTH 5 FT
 BOD LOADING 50 POUNDS/ACRE
 FACULATIVE LAGOON
 LINER REQUIRED 0.60 \$/SQFT
 END

Unit	Internal			
Process	Liquid			
Keyword	Process	LQADD(20,M)	NOQ(20)	
		MOD0	MODT ⁱ	MOD2
LAGO	20	(1764)	(~~2025~~) 2050	21

BANKDA(K)



NEXTAD = ~~2025~~
 Prior to
 reading unit
 process cards

NEXTAD = 2050
 after reading
 unit process
 cards

```

100  READ (5,101) IPROC, LXXX, LTLE
101  FORMAT (A4,A2,66A1)
9999 CALL SCAN (NN, VALUE, 66, LTLE)
      MODT = VALUE(1) + 1.01
      DO 1020 I = 1, NOLIQ
      IF (IPROC.EQ.LISQ(I)) GO TO 1021
1021  IF (LITTLE.EQ.0) GO TO 7021
7021  IF (LQADD(I,MODT).NE.0) GO TO 602
      LQADD(I,MODT) = NEXTAD
      NEXTAD = NEXTAD + NOQ(I)
602   KADD = LQADD(I,MODT)
      GO TO ( , , , , , , 27, , , , ), I
27    CALL ZLAGOI (BANKDA(KADD, ID(1, 387), MODT)
      GO TO 100
  
```

Figure 3. Unit Process Input Scheme

LAGOON MOD 1
 DEPTH 5 FT
 BOD LOADING 50 POUNDS/ACRE
 FACULATIVE LAGOON
 LINER REQUIRED 0.60 \$/SQFT
 END

BANKDA(K)

Unit	Internal			
Process	Liquid			
Keyword	Unit			
	Process	LQADD(20,M)		NOQ(20)
		MODO	MOD1	MOD2
LAGO	20	(1764)	(2029)	21

NEXTAD = 2029
 Prior to
 reading unit
 process cards

NEXTAD = 2050
 after reading
 unit process
 cards

```

100  READ (5,101) IPROC, LXXX, LITLE
101  FORMAT (A4,A2,66A1)
9999 CALL SCAN (NN, VALUE, 66, LITLE)
      MODT = VALUE(1) + 1.01
      DO 1020 I = 1, NOLIQ
      IF (IPROC.EQ.LISQ(I)) GO TO 1021
1021 IF (LITTLE.EQ.0) GO TO 7021
7021 IF (LQADD(I,MODT).NE.0) GO TO 602
      LQADD(I,MODT) = NEXTAD
      NEXTAD = NEXTAD + NOQ(I)
602  KADD = LQADD(I,MODT)
      GO TO ( , , , , , , 27, , , , ), I
27  CALL ZLAGOI (BANKDA(KADD), ID(1, 387), MODT)
      GO TO 100
  
```

Figure 3. Unit Process Input Scheme

```

SUBROUTINE ZLAGOI (RR, ID, MODT)
  DIMENSION ID(3,1), RR(1), LIST(8), KLM(74), VALUE(10)
  COMMON/QQCO/QQ(168)
  EQUIVALENCE(QQ(1),DC ), (QQ(2), FLBOD), (QQ(3), D),
> (QQ(4), XOSTSP), (QQ(5), COSLI), (QQ(6), ITYP),
> (QQ(7), SA), (QQ(8), V), (QQ(9), DT), (QQ(10), CSA),
> (QQ(11), NLC), (QQ(12), FL), (QQ(13), VLEW), (QQ(14), ALL),
> (QQ(15), DIA), (QQ(16), FLDIA), (QQ(17), NBV), (QQ(18), XOSTSV),
> (QQ(19), VCV), (QQ(20), VCS), (QQ(21), OMMH)
  DATA LIST/'BOD ', 'DEPT', 'LINE', 'AERO', 'FACU', 'ANAE', 'END ', 'ESTI'/
  DATA IA/'I'/
  CALL INIT (QQ,RR,21)
50  READ (5,100) KTYPE, LXX, KLM
  WRITE (6,951) KTYPE, LXX, KLM
951  FORMAT (' ', A4, A2, 74A1)
100  FORMAT (A4, A2, 74A1)
  CALL SCAN (NO, VALUE, 74, KLM)

  DO 51 I = 1, 8
  IF (KTYPE.EQ.LIST(I)) GO TO 52
51  CONTINUE
52  GO TO (1, 2, 3, 4, 5, 6, 7, 8), I
1  FLBOD = VALUE (1)
  ID(MODT, 1) = IA
  GO TO 50
2  D = VALUE (1)
  ID(MODT, 2) = IA
  GO TO 50
7  CALL INIT (RR, QQ, 21)
  RETURN
8  XOSTSP = VALUE (1)
  XOSTSV = VALUE (2)
  GO TO 50
  END

SUBROUTINE INIT (QQ, RR, N)
  DIMENSION RR(1)
  DIMENSION QQ(1)
  DO 1 J = 1, N
1  QQ(J) = RR(J)
  RETURN
  END

```

	RR(1)	BANKDA (KADD)
1	DC	
2	FLBOD	
3	D	
4	XOSTSP	
5	COSLI	
6	ITYP	
7	SA	
8	V	
17	NBV	
18	XOSTSV	
19	VCW	
20	VCS	
21	OMMH	

Figure 4. Unit Process Input Subroutine

2-5 Pseudo Treatment Processes. There are four pseudo processes which do not have associated subroutines. These processes are as follows:

<u>Internal Treatment Process Number</u>	<u>Keyword</u>
8	A MIX
9	B MIX
10	C MIX
11	NULL (Sludge)
29	NULL (Liquid)

The NULL process allows consideration of a NULL process condition in a block of a line (liquid, secondary sludge, or primary sludge). The A MIX, B MIX, and C MIX processes can be used only on the secondary sludge line and will cause processing of the secondary line to be terminated. As a result, the remaining secondary sludge will be mixed with the primary sludge prior to processing the first, second, or third blocks on the primary sludge line.

2-6 Treatment Process Modifications. Data may be given for three modifications of each of the unit processes associated with a treatment process. These modifications while externally numbered 0, 1, or 2 are internally numbered 1, 2, or 3 respectively. The internal unit process numbers indicate modification by adding 100 times the external modification number. Thus the numbers 1-80, 101-180 and 201-280 represent liquid treatment processes for modifications 0, 1, and 2 respectively while 81-100, 181-200, and 281-300 represent sludge treatment processes.

2-7 Treatment Scheme Input. Treatment schemes as specified on LINE (LIQUID, SECONDARY SLUDGE, and PRIMARY SLUDGE) and BLOCK cards are stored internally in tables MASTER, NO, KSTRT, and KEND. Table MASTER is a three-dimensional array which will accomodate four schemes, 20 blocks, and ten treatment processes per block. Internal treatment process numbers are stored in this table. The internal treatment process number identifies whether the process is a liquid or a sludge process, the name of the treatment process, and the modification of that treatment process (0, 1, or 2). Internal treatment process numbers stored in MASTER have the following representation.

1-80	Liquid Process	Modification 0
101-180	Liquid process	Modification 1
201-280	Liquid Process	Modification 2
81-100	Sludge Process	Modification 0
181-200	Sludge Process	Modification 1
281-300	Sludge Process	Modification 2

Table KSTRT is a two-dimensional array for four schemes and three lines per scheme. This table contains the block numbers in MASTER at which the particular line begins. Similarly, table KEND contains the ending block numbers for these lines.

The array NO has two dimensions, one for schemes and one for blocks. This table contains counts of the number of processes which appeared on the BLOCK cards.

LIQUID LINE
 BLOCK PRELIM
 BLOCK PRIMAR FLOTAT COAGUL NULL
 BLOCK DUMMY
 BLOCK TRICKL
 BLOCK NITRIF
 BLOCK FILTRA
 BLOCK CARBON
 BLOCK POST A
 BLOCK CHLORI
 SECONDARY SLUDGE LINE
 BLOCK SLUDGE A MIX
 BLOCK ANAERO B MIX
 BLOCK C MIX
 PRIMARY SLUDGE LINE
 BLOCK GRAVIT NULL
 BLOCK AEROBI ANAERO
 BLOCK DRYING VACUUM CENTRI

	Liquid	Secondary	Primary	
	1	10	13	KSTRT (1,L)
	9	12	15	KEND (1,L)
1 4 1 1 1 1 1 1 1 2 2 1 2 2 3				NO (1,J)
27 26 30 12 24 3 5 31 11 81 83 90 84 82 87				
2			88 89	91 83 85
25				86
29				

MASTER (1,I,J)

Figure 5. Internal Representation of a Treatment Scheme

An illustration of how a typical treatment scheme is represented in these tables is shown in Figure 5.

Listed below are the internal treatment process numbers for modification zero (0) along with the associated unit processes for the large and small systems.

Large System Treatment Processes

Internal Treatment Process Number (MOD 0)	Keyword From LISTPL	Treatment Process	Associated Unit Process Keywords
---	---------------------------	-------------------	--

LIQUID Treatment Processes (Maximum of 80 for each modification)

1	EQUA	Equalization	EQUA
2	FLOT	Flotation	FLOT
3	FILT	Filtration	FILT
4	MICR	Microscreening	MICR
5	CARB	Carbon Adsorption	CARB
6	COUN	Counter Current Ammonia Stripping	COUN
7	CROS	Cross Current Ammonia Stripping	CROS
8	CATI	Cation Exchange	CATI
9	ANIO	Anion Exchange	ANIO

<u>Internal Treatment Process Number (MOD 0)</u>	<u>Keyword From LISTPL</u>	<u>Treatment Process</u>	<u>Associated Unit Process Keywords</u>
10	NEUT	Neutralization	NEUT
11	CHLO	Chlorination	CHLO
12	TRIC	Trickling Filter	TRIC, T SE
13	COMP	Complete Mix Activated Sludge	COMP, A SE
14	STEP	Step Aeration Activated Sludge	STEP, A SE
15	PLUG	Plug Flow Activated Sludge	PLUG, A SE
16	HIGH	High Rate Activated Sludge	HIGH, A SE
17	PURE	Pure Oxygen Activated Sludge	PURE, P SE
18	EXTE	Extended Aeration Activated Sludge	EXTE, A SE
19	CONT	Contact Stabilization Activated Sludge	CONT, A SE
20	LAGO	Lagoon	LAGO
21	AERA	Aerated Lagoon	AERA
22	RAW	Raw Sewage Pumping -	RAW
23	OXID	Oxidation Ditch	OXID, O SE
24	NITR	Suspended Growth Nitrification	NITR, N SE
25	COAG	Coagulation	COAGUL
26	PRIM	Primary Clarification	PRIM
27	PREL	Preliminary Treatment	GRIT, SCRE COMM
28	DENI	Suspended Growth Denitrification	DENI, D SE
29	NULL	Null Process	None
30	DUMM	User Specified Process	DUMMY
31	POST	Post Aeration	POST
32	RBC	Rotating Biological Contactor	RBC
33	ATTA	Attached Growth Denitrification	ATTA

<u>Internal Treatment Process Number (MOD 0)</u>	<u>Keyword From LISTPL</u>	<u>Treatment Process</u>	<u>Associated Unit Processes Keywords</u>
34	RECA	Recarbonation	RECA
35	TWO	Two Stage Line Treatment	FLOC, L SE, FIRS, SECO
36	OVER	Overland Flow Land Treatment	OVER
37	RAPI	Rapid Infiltration Land Treatment	RAPI
38	SLOW	Slow Infiltration Land Treatment	SLOW
39	Not Used		
40	Not Used		
41	Not Used		
42	PUMP	Pumping	PUMP
43	N RB	Nitrification - RBC	N RB
44	N TR	Nitrification - Trickling Filter	N TR

<u>Internal Treatment Process Number (MOD 0)</u>	<u>Keyword From LISTPS</u>	<u>Treatment Process</u>	<u>Associated Unit Process Keywords</u>
--	------------------------------------	--------------------------	---

SLUDGE Treatment Processes (maximum of 20 for each modification)

81	SLUD	Sludge Flotation	SLUD
82	AERO	Aerobic Digestion	AERO
83	ANAE	Anaerobic Digestion	ANAE
84	GRAV	Gravity Thickening	GRAV
85	VACU	Vacuum Filtration	VACU
86	CENT	Centrifugation	CENT
87	DRYI	Drying Beds	DRYI
88	A MI	Sludge Mixing Process	
89	B MI	Sludge Mixing Process	

Internal Treatment Process Number (MOD 0)	Keyword From <u>LISTPS</u>	<u>Treatment Process</u>	Associated Unit Process Keywords
90	C MI	Sludge Mixing Process	
91	NULL	Null Process	
92	HAUL	Hauling and Land Filling	HAUL
93	MULT	Multiple Hearth Incineration	MULT
94	FLUI	Fluidized Bed Incineration	FLUI
95	FLTR	Filter Press	FLTR
96	PRES	Pressure Filtration	PRES
97	WET	Wet Oxidation	WET
98	USER	User Specified Sludge Process	USER

Small System Treatment Processes

Internal Treatment Process Number (MOD 0)	Keyword From <u>LISTPL</u>	<u>Treatment Process</u>	Associated Unit Process Keywords
---	----------------------------------	--------------------------	--

LIQUID Treatment Processes (maximum of 80 for each modification)

1	EQUL	Equalization	EQUL
2	FLOT	Flotation	FLOT
3	FILT	Filtration	FILT
4-10	Not Used		
11	CHLO	Chlorination	CHLO
12	TRIC	Trickling Filter	TRIC, T SE
13-19	Not Used		
20	LAGO	Lagoon	LAGO
21	AERA	Aerated Lagoon	AERA
22	RAW	Raw Sewage Pumping	RAW

<u>Internal Treatment Process Number (MOD 0)</u>	<u>Keyword From LISTPL</u>	<u>Treatment Process</u>	<u>Associated Unit Process Keywords</u>
23	OXID	Oxidation Ditch	OXID
24	Not Used		
25	COAG	Coagulation	COAG
26	PRIM	Primary Clarification	PRIM
27	PREL	Preliminary Treatment (Screening)	SCRE
28-29	Not Used		
30	DUMM	User Specified Process	DUMM
31	POST	Post Aeration	POST
32-35	Not Used		
36	OVER	Overland Flow Land Treatment	OVER
37	RAPI	Rapid Infiltration Land Treatment	RAPI
38	SLOW	Slow Infiltration Land Treatment	SLOW
39	SEPT	Septic Tanks	SEPT
40	ACTI	Activated Sludge	ACTI
41	INTE	Intermittent Sand Filters	INTE
42	PUMP	Pumping	PUMP
43-44	Not Used		

<u>Internal Treatment Process Number (MOD 0)</u>	<u>Keyword From LISTPS</u>	<u>Treatment Process</u>	<u>Associated Unit Process Keywords</u>
--	------------------------------------	--------------------------	---

SLUDGE Treatment Processes (maximum of 20 for each modification)

81	SLUD	Sludge Drying Lagoons	SLUD
82-86	Not Used		
87	DRYI	Drying Beds	DRYI
88-93	Not Used		
94	USER	User Specified Sludge Process	USER

2-8 Train Identification Algorithm. In addition to tables MASTER and NO which were described earlier, three other tables are used in the train identification algorithm. The tables are all 20-position arrays, and are named KNT, LMT, and MAST.

Table KNT may be viewed as a 20-cog odometer which has a variable number of faces on each cog. Table LMT specifies the number of faces on each cog of KNT. The positions in LMT may also be thought of as limit switches on KNT. Except for inactive positions the odometer KNT does not contain a zero on any of the faces. Thus the initial setting is a one on every face. The settings on the faces of this odometer indicate the positions of each BLOCK of MASTER to be included in this train. Figure 6 shows a set of values in LMT and the possible settings in KNT in order of their occurrence.

Internal treatment process numbers from table MASTER as indicated by the settings in KNT are copied into table MAST. Table MAST then contains only those internal treatment process numbers which make up the train along with the current scheme number. The start and end tables KSTRT and KEND, the printing indicator, IPRT, and the analysis indicator, LANA, are passed through the call statement to subroutine PROCES for design and evaluation of this train. A more detailed description of subroutine PROCES is provided in Chapter 3. It should be noted here, however, that subroutine PROCES will place this train in the save table TABLE in order of cost if the train meets the effluent requirements. Subroutine PROCES is called once for each train in the order the trains are identified by the settings in the table KNT. After all trains have been processed the TABLE table will contain the trains which meet the effluent requirements along with the costs of each train. The trains will be ranked in this table in order of increasing equivalent annual treatment cost.

LMT

1 2 1 1 3 1 2 1 0 0 0

Inactive
Positions

1	1	1	1	1	1	1	1
1	1	1	1	1	1	2	1
1	1	1	1	2	1	1	1
1	1	1	1	2	1	2	1
1	1	1	1	3	1	1	1
1	1	1	1	3	1	2	1
1	2	1	1	1	1	1	1
1	2	1	1	1	1	2	1
1	2	1	1	2	1	1	1
1	2	1	1	2	1	2	1
1	2	1	1	3	1	1	1
1	2	1	1	3	1	2	1

Possible Settings
of Active Positions
of KNT

MASTER

27	26	30	81	90	81	82	87
	2			87		83	
				85			

MAST

27	2	30	81	85	81	83	87
----	---	----	----	----	----	----	----

Figure 6. Treatment Train Selection System

2-9 Waste Stream and Desired Effluent Data Input. Waste stream data are read by subroutine WASTIN and stored in named common/LIQUID/. This data array will never be changed but will be used to generate the liquid line prior to the processing of each train. This liquid line initialization is accomplished by copying the liquid influent characteristics into the variable USE in blank common. Default data have been loaded into LIQUIDA in subroutine BLOCKDATA for all of the constituents except for the three flows. The 20 constituents of the waste stream and each constituent's location in the array USE, four-character keyword, and default value are shown below.

<u>Location in Array USE</u>	<u>Waste Influent Constituent</u>	<u>Variable Name in Common</u>	<u>Waste Influent Keyword</u>	<u>Default Value</u>
1	Minimum Flow (mgd)	QMIN	MINI	0.0
2	Average Flow (mgd)	QAVE	AVER	0.0
3	Maximum Flow (mgd)	QMAX	MAXI	0.0
4	Temperature (°C)	TEMP	TEMP	18.0
5	Suspended Solids (mg/l)	SOLIDS	SUSP	200.0
6	Volatile Solids (% of SS)	VOLAT	VOLA	60.0
7	BOD5 (mg/l)	BOD5	BOD5	250.0
8	Soluble BOD (mg/l)	BOD5S	SBOD	75.0
9	COD (mg/l)	COD	COD	500.0
10	Soluble COD (mg/l)	CODS	SCOD	400.0
11	Ph	PH	PH	7.6
12	Cations (mg/l)	CIC	CATI	160.0
13	Anions (mg/l)	CAC	ANIO	160.0
14	Total Kjeldahl Nitrogen (mg/l) of Nitrogen)	TKN	TKN	45.0

<u>Location in Array USE</u>	<u>Waste Influent Constituent</u>	<u>Variable Name in Common</u>	<u>Waste Influent Keyword</u>	<u>Default Value</u>
15	Phosphorus (mg/l)	PO4	PO4	18.0
16	Ammonia (mg/l of Nitrogen)	FNH3	NH3	25.0
17	Settleable Solids (ml/l)	SETSO	SETT	15.0
18	Oil and Grease (mg/l)	OAG	OIL	80.0
19	Nitrites (mg/l) of Nitrogen)	ANO2	NO2	0.0
20	Nitrates (mg/l of Nitrogen)	ANO3	NO3	0.0

Desired effluent characteristics are ready by subroutine DESIIN. Prior to calling this subroutine, the executive routine sets each of the desired effluent characteristics in array DESIDA to minus one (-1.0). This value is used as an indicator to specify that no checking is to be performed on this constituent. Of course this indicator can be replaced with a desired value from a particular constituent card. That constituent in the effluent will be checked to determine if the particular train will satisfy the effluent requirements. The user input for the desired effluent characteristics uses the same 20 constituents of the waste listed above. The array DESIDA is located in the labelled common DESICO.

2-10. Unit Cost Data Input. The unit cost data are read by subroutine UNITIN and stored in labelled commons UNITCO, PERCCO, STESPE, and EPACCI. Default values for each of the unit cost items have been loaded into UNITCO and PERCCO in subroutine BLOCKDATA. In the case of the

four eight-inch pipe items and the three standard blowers, however, zeroes (0.0) are loaded in subroutine BLOCKDATA and first quarter 1977 costs are defaulted to and updated using the Pipe Cost (pipe) and Marshall and Swift (blowers) Indices. All other unit cost items are NOT UPDATED with any cost index and the user-specified or default values are used directly in the third-order costing algorithms. Provided below are the unit cost items, variable names, and default values. The unit cost input section is terminated with the sentinel END card.

<u>Unit Cost Number in LIST</u>	<u>Unit Cost Item</u>	<u>Unit Cost Keyword</u>	<u>Variable Name</u>	<u>Default Value</u>
1	Building Cost (\$/sqft)	BUIL	UPIBC	48.00
2	Excavation (\$/cuyd)	EXCA	UPIEX	1.20
3	Wall Concrete (\$/cuyd)	WALL	UPICW	207.00
4	Slab Concrete (\$/cuyd)	SLAB	UPICS	91.00
5	Marshall and Swift Index	MARS	FMSECI	577.00
6	Crane Rental (\$/hr)	CRAN	UPICR	67.00
7	Small City EPA Index	SMAL	EPACI ^a	None
8	Canopy Roof (\$/sqft)	CANO	UPIR	15.75
9	Installation Labor Rate (\$/hr)	LABO	FLABRI	13.40
10	Class II Operator Labor Rate (\$/hr)	OPER	SALOP	7.50
11	Electricity (\$/kwhr)	ELEC	UPIPC	0.04

<u>Unit Number in LIST</u>	<u>Unit Cost Item</u>	<u>Unit Cost Keyword</u>	<u>Variable Name</u>	<u>Default Value</u>
12	Chemicals	CHEM		
	Lime (\$/lb)		CHEM(1)	0.03
	Alum (\$/lb)		CHEM(2)	0.04
	Iron Salts (\$/lb)		CHEM(3)	0.06
	Polymers (\$/lb)		CHEM(4)	1.62
13	Engineering News Record Index	ENGI	ENRCCI	2886.00
14	Handrails (\$/ft)	HAND	UPIHR	25.20
15	Pipe Cost Data	PIPE		
	Pipe Cost Index		CEPCIP	295.20
	Pipe Installation Labor (\$/hr)		FLABII	14.70
16	Eight-inch Pipe Costs	EIGH		
	Pipe (cast iron - \$/ft)		CCIPS	0.0 (7.41) ^b
	Bend (cast iron - \$/unit)		CCRS	0.0 (70.88) ^b
	Tee (cast iron - \$/unit)		COTS	0.0 (104.90) ^b
	Valve (cast iron - \$/unit)		CCPUS	0.0 (1099.00) ^b
17	Not Used			
18		END ^b		
19	Large City EPA Index	LARG	EPACI ^a	132.00
20	Standard Blowers	BLOW		
	3000 scfm Blower		COSTSB(1)	0.0 (16,000) ^c
	12000 scfm Blower		COSTSB(2)	0.0 (45,000) ^c
	50000 scfm Blower		COSTSB(3)	0.0 (300,000) ^c

<u>Unit Number in LIST</u>	<u>Unit Cost Item</u>	<u>Unit Cost Keyword</u>	<u>Variable Name</u>	<u>Default Value</u>
21	Land	LAND	FLAND	1000.00
22	Miscellaneous Nonconstruc- tion (%)	MISC	PMISC	5.00
23	Administrative and Legal (%)	ADMI	PADMI	2.00
24	201 Planning (%)	201	P201	3.50
25	Inspection (%)	INSP	PINSP	2.00
26	Contingencies (%)	CONT	PCONT	8.00
27	Profit and Overhead (%)	PROF	PPROF	22.00
28	Technical (%)	TECH	PTECH	2.00
29	Special Foundations ^d	SPEC		
	Indicator		IFOUN	0
	User-specified Cost		FOUN	None
30	Effluent Pumping ^d	PUMP		
	Indicator		IEFPU	0
	User-specified Cost		EFPU	None
31	Not Used			
32	Outfall Diffusers ^d	DIFF		
	Indicator		IEFDI	0
	User-specified Cost		EFDI	None

<u>Unit Number in LIST</u>	<u>Unit Cost Item</u>	<u>Unit Cost Keyword</u>	<u>Variable Name</u>	<u>Default Value</u>
33	Mobilization ^d	MOBI		
	Indicator		IMOB	0
	User-specified Cost		FMOB	None
34	Site Preparation ^d	CLEA		
	Indicator		ISITE	0
	User-specified Cost		SITE	None
35	Site Electrical ^d	SITE		
	Indicator		IELEC	0
	User-specified Cost		ELEC	None
36	Instrumentation and Control ^d	INST		
	Indicator		ILAC	0
	User-specified Cost		FLAC	None
37	Yard Piping ^d	YARD		
	Indicator		IMYRP	0
	User-specified Cost		FMYRP	None
38	Raw Waste Pumping ^d	RAW		
	Indicator		LPUMP	0
	User-specified Cost		PUMP	None
39	Lab/Maint/Admin Building ^d	LAB		
	Indicator		ILAB	0
	User-specified Cost		FLAB	None

<u>Unit Number in LIST</u>	<u>Unit Cost Item</u>	<u>Unit Cost Keyword</u>	<u>Variable Name</u>	<u>Default Value</u>
40	Effluent Piping ^d	EFFL		
	Indicator		IGRAV	0
	User-specified Cost		GRAV	None

^aThe EPA cost indices are used to update all of the parametric cost curves in CAPDET. Only one of the indices should be specified by the user. The default index is the Large City EPA Index. The user-specified (or default) index is stored as EPACI in labelled common EPACII. In addition, the first quarter 1977 index is stored in variable DIVSOR in common EPACII. For the Small EPA Index, DIVSOR is set to 121.00, and for the Large City EPA Index, DIVSOR is set to 132.00.

^bFirst Quarter 1977 unit costs for each eight-inch pipe item are shown in parentheses. Any of the four costs which are not specified by the user (or input as 0.0) are updated by the user-specified Pipe Cost Index when the END sentinel card is input. For example, if the variable CCIPS is not input, it will have the value

$$CCIPS = 7.41 * (PIPE INDEX) / 241.0$$

Any of the four cost items which are specified by the user will NOT BE UPDATED by any cost index.

^cFirst quarter 1977 costs for the standard blowers are shown in parentheses. Any of the three costs which are not specified by the user (or input as 0.0) are updated by the user-specified Marshall and Swift Index in subroutine AIRPR. For example if the variable COSTSB(2) is not input, it will have the value

$$\text{COSTSB}(2) = 45000.0 * (\text{Marshall \& Swift}) / 491.60$$

Any of the three blower costs which are specified by the user will NOT BE UPDATED by any cost index.

^dOptional direct cost items which are added to project cost ONLY IF SPECIFIED BY THE USER. If the user wants to use a national average for any of the direct cost items, the four-character keyword may be specified with no additional data provided. The cost will be calculated using 1977 parametric equations based on average flows from MCD-37 and will be updated with the user specified EPA index. If the user desires to specify a cost to be used, the four-character keyword is provided with the cost in dollars. That cost will be used with NO UPDATING by any cost index.

2-11 Program Control Card Input. CAPDET output control consists of five optional specifications and one required specification. The GO card is required and should be the last input as it causes CAPDET to begin its execution phase. The user specifies two values on the GO card, the desired interest rate in percent and the project design life in years.

The LIST TRAINS option specifies that a number of trains be listed as to a schematic of the liquid line and the secondary and primary sludge lines treatment processes and modification numbers. In addition, the total construction cost, annual O & M cost, and equivalent annual cost of each train is output. The number of trains to be printed is stored in the variable NOTRA. The internal treatment process numbers of the trains are contained in TABLE. These numbers are used to set the modification number of each process in table MISTRA and to identify the keywords to be placed in table LISTRA. These keywords are obtained from LISTPL or LISTPS for liquid and sludge processes respectively. These two tables are used to produce the output for the train listing. The trains are numbered in order of their position in TABLE. The treatment trains are ordered by ascending equivalent annual cost in TABLE before output is accomplished.

The ANALYZE option sets the value of LANA to one (1) and the value of IPRT to one (1). The values of these variables will cause PROCES to output the first-order design data for the unit processes,

influent and effluent of each treatment process, and the cost summary table. The output occurs as the train is processed and before any economic ranking is accomplished.

The PRINT TRAINS option specifies that first-order design data for the unit processes, influent and effluent of each treatment process, and the cost summary table will be output AFTER economic ranking has been accomplished. LANA and IPRT are set to zero (0) for the first call to subroutine PROCES which designs the trains but provides no output. The trains are then ranked economically and arranged in TABLE. NOPRO is the number of trains to be printed and array NUMS has the train numbers (maximum of 25) that are to be output from TABLE. The train numbers correspond to positions in TABLE. The internal treatment process numbers from TABLE are then passed to subroutine PROCES with IPRT set to one(1) and the liquid and sludge lines initialized. The train is redesigned by PROCES exactly as on its first pass but this time the results of the design are printed. No train evaluation is conducted by PROCES during this pass since only an output listing is desired.

The OUTPUT QUANTITIES option causes the variable KCTL to be set to one (1). KCTL is located in unlabelled COMMON with IPRT and the waste constituents in the USE array. As first-order design data are output by either the PRINT or ANALYZE options, a KCTL value of one (1) will cause the second-order design data to be output.

The SUMMARY ONLY option causes the suppression of all PRINT or ANALYZE output with the exception of the influent and final effluent of the train and the cost summary page. The variable ISSO is set to one (1) and IPRT is set to two (2). Either the PRINT or ANALYZE option must accompany the SUMMARY ONLY option.

The GO card is the last card of the input data. The interest rate, RATE, and the project design life, NOPER, are stored and the execution of CAPDET begins. A more detailed explanation of program control is presented in Chapter 3.

CHAPTER 3

SUBROUTINE PROCES

3-1 General. Subroutine PROCES controls the unit process design, effluent evaluation, and cost evaluation for the trains passed to the subroutine by the executive routine. If the print indicator IPRT is set the results of the design routines will be printed. Unit processes are designed by order of appearance of associated treatment processes in the train. The effluent from one treatment process becomes the influent to the next treatment process in order. Process design and effluent estimation are accomplished by the 'EX'-suffixed subroutines while output is performed by the 'OT'-suffixed subroutines. Data addresses in BANKDA are established prior to calling these subroutines. Within each of these subroutines the data are moved into the equivalenced array at the beginning of execution from the table BANKDA. In the case of the execution routines the data are then moved back into BANKDA at the end of the routine before the RETURN statement.

3-2 Cost Estimating Routines. Separate pricing routines have been developed for those unit processes which were included in CAPDET prior to 1978. These routines have the characters 'PR' and 'QU' appended to the process acronym for a name. The 'PR' routine calculates the quantities and costs of the items associated with the unit process. The 'QU' routine is an output routine which is optionally called for the unit process if the OUTPUT QUANTITIES (see section 2-11) card was specified. The 'PR' routine is called from both the

the 'EX' routine and from the 'OT' routine. This arrangement negates the need of passing all the calculated quantities back to the 'EX' routine for storage in BANKDA. The control variable IQU prevents the recalculation of quantities when the 'PR' routine is called from the 'OT' routine. If the value of IQU passed to the 'PR' routine is zero the quantities will be calculated and the 'QU' routine will not be called. If IQU is equal to one, the 'PR' routine will not calculate quantities and will call the 'QU' routine if the print indicator LPRT is equal to one (1). The 'EX' routine calls the 'PR' routine with IQU = 0 while the 'OT' routine calls the 'PR' routine with IQU = 1. The subroutine structures for these routines are shown in Figure 7. For those routines implemented in CAPDET after 1978 the functions of the 'PR' and 'QU' routines are included in the 'EX' and 'OT' routines respectively. For this case the quantity data are included in BANKDA. The subroutine structures for these routines are shown in Figure 8.

SUBROUTINE FILTEX (RR)

(Design Formulation)

CALL FILTPR (, , , 0)
↑ IQU

RETURN

END

SUBROUTINE FILTOT (RR, ID, MODT)

(Design output)

CALL FILTPR (, , , 1)
↑ IQU

RETURN

END

SUBROUTINE FILTPR (, , , IQU)

IF (IQU.EQ.1) GO TO 678

First executable statement

(Cost Formulation)

RETURN

678 IF (KCTL.EQ.1) CALL FILTQU () (Quantity Output)

RETURN

END

Figure 7. Subroutine Organization in Processes Developed Prior to 1978.

SUBROUTINE CARBEX (RR)

(Design Formulation)

(Cost Formulation)

RETURN

END

SUBROUTINE CARBOT (RR, ID, MODT)

(Design Output)

IF (KCTL.NE.1) RETURN

(Quantity Output)

RETURN

END

Figure 8. Subroutine Structure for Processes Developed After 1978.

3-3 Pseudo Processes. There are no execution or output routines for the pseudo processes NULL, A MIX, B MIX AND C MIX. The NULL process is a 'no operation' process. It does not cause alteration of any of the in-line waste constituents and is used in some trains to examine the option of leaving a block or process out of the train. Also those processes which follow a mixing block on the secondary line will be changed to a NULL process.

If a mix process is encountered during the processing of the secondary sludge line, the mixing indicator is set according to the position at which the mixing is to be accomplished on the primary line. The mixing indicators are as follows: 1 for A MIX; 2 for B MIX, and 3 for C MIX. The processes in the blocks which follow on the secondary sludge line are changed to NULL. Prior to executing any process on the primary sludge line the mixing indicator is compared with the block position number on the primary sludge line. If the two agree, then the contents of the secondary sludge line are mixed with the contents of the primary sludge line. The secondary sludge line is then set to zero.

3-4 Treatment Process - Unit Process Relationship. Several treatment processes involve more than one unit process. Normally there is neither means, nor need for communication of data items between the various unit processes. In those cases where data must be transferred between unit processes, the second unit processes must be called or executed by the first. Special care must be taken not to destroy the data interface

in these cases. This will involve the use of a secondary equivalenced array. The pertinent coding for 'independent' and 'dependent' unit process execution is shown in Figures 9 and 10.

3-5 Train Save Table. The array TABLE is used to store those trains which meet effluent requirements. The internal treatment process numbers of the train, its scheme number, and cost data are stored in the order of the equivalent annual treatment cost of the train. This array is dimensioned 24 by 100. The first column contains the scheme number, columns two through 21 contain the internal process numbers and the last three columns contain the capital cost, the annual operating costs, and the amortized capital costs.

After it has been determined that a train meets the required effluent standards, the treatment costs of any trains already in TABLE are examined. The line number of the first train with a higher treatment cost is determined. This train and all which follow it are moved down to make room for the new, more economical train. The new train is inserted in the table and the count of saved trains is increased by one. Only the 100 most economical trains are saved.

From Subroutine PROCES

```

34      KADD = LQADD (27, MODT)
        CALL GRITEX (BANKDA(KADD))
        KADD = LQADD ( 28, MODT)
        CALL SCRNX (BANKDA(KADD))
        KADD = LQADD (29, MODT)
        CALL COMEX (BANKDA(KADD))
        IF (IPRT.NE.1) GO TO 100
        KADD = LQADD (28, MODT)
        CALL SCRNOT (BANKDA(KADD), ID(1,157),MODT)
        KADD = LQADD (27, MODT)
        CALL GRITOT (BANKDA(KADD), ID(1,146),MODT)
        KADD = LQADD (29, MODT)
        CALL COMMOT (BANKDA(KADD),ID(1,164), MODT)
        GO TO 100

```

grit chamber
data address

bar screen
data address

comminator
data address

```

SUBROUTINE GRITEX (RR)
  DIMENSION RR(1)
  COMMON/QQCO/qq(168)
  CALL INIT (QQ,RR,25)

```

All three execution sub-
routines may be coded
similar to this.
COMMON/QQCO/ may be
used in each.

```

14      CALL INIT (RR,QQ,25)
        RETURN
        END

```

```

SUBROUTINE GRITOT (RR,ID,MODT)
  DIMENSION RR(1), ID(3,1)
  COMMON/QQCO/qq(168)
  CALL INIT (QQ,RR,25)

```

All three output
subroutines may be
coded similar to this.
COMMON/QQCO/ may be
used in each.

```

RETURN
END

```

Figure 9. Independent Unit Process Data Interface

From Subroutine PROCES

```
20 KADD = LQADD (13, MODT)
   CALL CMASEX (BANKDA(KADD), MODT)
   IF (IPRT. EQ. 1) CALL CMASOT(BANKDA(KADD), ID(1,34), MODT)
   KADD = LQADD (31, MODT)
   IF (IPRT. EQ. 1) CALL SECOOT (BANKDA(KADD), ID(1,165), MODT)
   GO TO 100
```

```
SUBROUTINE CMASEX (RR, MODT)
  DIMENSION RR(1)
  COMMON/ADDRCO/LQADD(80,3),LSADD(20,3)
  CALL INIT (QQ,RR,36)
```

```
SUBROUTINE CMASOT (RR, ID, MODT)
  DIMENSION RR(1), ID(3,1)
  COMMON/QQCO/QQ(168)
  CALL INIT (QQ,RR,36)
```

```
KADD = LQADD (31, MODT)
CALL SECOEX ( -, -, -, -, BANKDA(KADD))
```

```
CALL INIT (RR, QQ, 36)
RETURN
END
```

```
RETURN
END
```

```
SUBROUTINE SECOEX (-,-,-,RR)
  DIMENSION RR(1)
  COMMON/XXCO/QQ(168)

  CALL INIT (QQ,RR,23)
```

```
SUBROUTINE SECOOT (RR,ID,MODT)
  DIMENSION RR(1),ID(3,1)
  COMMON/QQCO/QQ(168)

  CALL INIT (QQ,RR,23)
```

```
CALL INIT (RR,QQ,23)
RETURN
END
```

```
RETURN
END
```

Note use of
secondary equivalence
array XXCO.

Figure 10. Dependent Unit Process Data Interface

3-6 Small Facilities. When the small facility indicator is set (LITTLE = 1) subroutine PROCES will call subroutine SMALEX for process execution and output. This in effect establishes a different set of data addresses for the various unit processes. The purpose of this arrangement is to allow the same unit process and treatment process names to be used for both large and small facilities.

All functions other than process execution and output are retained in subroutine PROCES. These functions include train initialization, BLOCK sequencing, economic ranking, effluent checking and summary page output.

3-7 Anaerobic Digester Supernatant. If an anaerobic digester is included in the train, an estimate of its supernatant will be made and will be mixed with the liquid line prior to the first or second BLOCK on the train. If the first process on the train is preliminary treatment the supernatant is mixed prior to the second BLOCK, otherwise it is mixed prior to the first BLOCK. The supernatant is estimated and mixed into the liquid line by calling subroutine ANAMIX. One estimate of the supernatant is made for sludges generated by a trickling filter while a different estimate is made for all other types of sludges.

CHAPTER 4

SUBROUTINE FIGURE

4-1 General. Subroutine FIGURE provides for the cost summary page for each treatment train that is to be output by the PRINT TRAINS or ANALYZE output options (see section 2-11). Subroutine PROCES calls FIGURE immediately after the train schematic (treatment processes and modification numbers by LIQUID and SECONDARY and PRIMARY SLUDGE lines) is output.

4-2 FIGURE Subroutine Arguments. Three variables constitute the arguments to subroutine FIGURE. The variables SUMC, SUMO, and SUMA are calculated in FIGURE and passed back to subroutine PROCES. SUMC is the total sum of capital construction costs, SUMO is the sum of the annual operation and maintenance costs, and SUMA is the total equivalent annual cost of the treatment train. These three costs are then put in columns 22, 23, and 24 of TABLE for the train in subroutine PROCES.

4-3 Common SUMMCO. Labelled common SUMMCO is used to store the cost data for each unit process in a particular treatment train. Immediately before subroutine PROCES begins the execution of a treatment train SUMMDA is completely set to zero (0.0). For any treatment train, SUMMDA will allow up to 30 unit processes with 17 items stored for each unit process. The following table lists the data items which are stored in SUMMDA by the costing routines for each unit process.

<u>Data Item Number</u>	<u>Description</u>	<u>Units</u>	<u>Variable Name</u>
1	Total Construction Cost	Dollars	TECC
2	Operation Manpower	Man-hr/yr	OEM
3	Maintenance Manpower	Man-hr/yr	FTMH
4	Annual Electricity	Kwhr/yr	FKWH
5	Replacement Schedule	Years	RS
6	Annual O & M Material Cost	Dollars/yr	OMMC
7	Air Requirement	Scfm	CFMD
8	Costing Indicator	0 or 1	ESTIM
9	Process Number		FNUM
10	Daily Lime Dosage	Lbs/day	CR
11	Daily Alum Dosage	Lbs/day	CR
12	Daily Iron Salts Dosage	Lbs/day	CR
13	Daily Polymer Dosage	Lbs/day	CR
14	Annual Lime Requirement	Lbs/year	FLIME
15	Annual Alum Requirement	Lbs/year	ALUM
16	Annual Iron Salts Requirement	Lbs/year	FIRON
17	Annual Polymer Requirement	Lbs/year	CRPY

The daily chemical requirements are saved for each unit process so that the sum of the daily requirements may be used to design the chemical feed system. The annual chemical requirements are saved so that the annual chemical costs may be calculated and included in the total operation and maintenance costs of the unit process and the overall treatment train.

4-4 Unit Process Identification. Each unit process is labelled by a eight-character name on the cost summary page. This eight-character name is made up of two four-character variables, LISQ and LISQ2 (liquid) or LISS and LISS2 (sludge) and is referenced from the process number, FNUM, stored in SUMMDA. In addition, the process number, FNUM, is used to load any user-specified unit costs (see sections 3-14 and 4-7 of the CAPDET User's Guide) from USERDA into SUMMDA by the variable ISW. The table below lists the liquid and sludge unit processes with each process's process number, eight-character name and user specified cost (ISW) number as identified from the array LIST in subroutine USERIN.

Large and Small System Liquid Unit Process

<u>Process Number</u>	<u>Unit Process Name</u>	<u>Process LISQ</u>	<u>Name LISQ2</u>	<u>ISW User Specified Cost Number</u>
1	Equalization	EQUA	LIZA	8
2	Flotation	FLOT	ATIO	9
3	Filtration	FILT	RATI	10
4	Microscreening	MIC	SCRN	11
5	Carbon Adsorption	CARS	ADS	12
6	Counter Current Ammonia Stripping	COUN	FLO	13
7	Cross Current Ammonia Stripping	CROS	FLO	14
8	Cation Exchange	CATI	ON X	15
9	Anion Exchange	ANIO	N EX	16

<u>Process Number</u>	<u>Unit Process Name</u>	<u>Process LISO</u>	<u>Name LISO2</u>	<u>ISW User Specified Cost Number</u>
10	Neutralization	NEUT	RALI	17
11	Chlorination	CHLO	RINA	18
12	Trickling Filters	TRIC	FIL	19
13	Complete Mix Activated Sludge	COMP	MIX	20
14	Step Aeration Activated Sludge	STEP	AER	21
15	Plug Flow Activated Sludge	PLUG	FLO	22
16	High Rate Activated Sludge	HIGH	RAT	23
17	Pure Oxygen Activated Sludge	PURE	OXY	24
18	Extended Aeration Activated Sludge	EXTE	AER	25
19	Contact Stabilization Activated Sludge	CONT	STA	26
20	Lagoon	LAGO	ONS	27
21	Aerated lagoon	AER	LAGO	28
22	Sludge Recycle Pumping	SLU	PUMP	80
23	Oxidation Ditch	OXID	DIT	30
24	Suspended Growth Nitrification	NITR	IFIC	31
25	Not Used			80
26	Primary Clarification	PRIM	CLA	33
27	Not Used			80
28	Screening (Small)	SCRE	ENS	35
29	Wash Water Pumping	WSH	PUMP	80
30	Recycle Pumping	RCY	PUMP	80
31	Secondary Clarifier - Activated Sludge	A SE	C CL	38

<u>Process Number</u>	<u>Unit Process Name</u>	<u>Process LISQ</u>	<u>Name LISQ2</u>	<u>ISW User Specified Cost Number</u>
32	Secondary Clarifier - Nitrification	N SE	C CL	39
33	Secondary Clarifier - Trickling Filter	T SE	C CL	40
34	Suspended Growth Denitrification	DENI	TRIF	41
35	User Specified Process	DUMM	Y	45
36	Post Aeration	POST	AER	46
37	Rotating Biological Contactor	RBC		47
38	Recarbonation	RECA	RBON	48
39	Flocculation	FLOC	CULA	49
40	Primary Clarifier - Lime Treatment	L PR	M CL	50
41	First Stage Lime Treatment	TWO	ST L	51
42	Second Stage Lime Treatment	SEC	STAG	52
43	Overland Flow Land Treatment	OVER	LAND	54
44	Rapid Infiltration Land Treatment	RAPI	D IN	55
45	Slow Infiltration Land Treatment	SLOW	INF	56
46	Septic Tank (Small)	SEP	TANK	57
47	Activated Sludge (Small)	ACT	SLUD	58
48	Intermittent Sand Filter (Small)	INT	FLTR	59
49	Secondary Clarifier - Pure Oxygen	P SE	C CL	60
50	Secondary Clarifier - Oxidation Ditch	O SE	C CL	61
51	Mechanical Aeration	MECH	AIR	42
52	Diffused Aeration	DIFF	AIR	43
53	Pumping	INT	PUMP	44
54	Secondary Clarifier - RBC	R SE	C CL	53

<u>Process Number</u>	<u>Unit Process Name</u>	<u>Process LISO</u>	<u>Name LISQ2</u>	<u>ISW User Specified Cost Number</u>
55	Line Feed System	LIME	F/S	
56	Alum Feed System	ALUM	F/S	
57	Iron Salts Feed System	IRON	F/S	
58	Polymer Feed System	POLY	F/S	
59	Blowers	BLOW	ERS	
60	Coagulation	COAG	F/C	68
61	Preliminary Treatment	PREL	DMIN	34
62	Secondary Clarifier - Denitrification	D SZ	C CL	69
63	Attached Growth Denitrification	ATT	DENI	70
64	Nitrification - RBC	N RB	C	71
65	Nitrification - Trickling Filter	N TR	FLT	72
66	Raw Sewage Pumping	RAW	PUMP	73

Large and Small System Sludge Unit Processes

<u>Process Number</u>	<u>Unit Process Name</u>	<u>Process LISS</u>	<u>Name LISS2</u>	<u>ISW User Specified Cost Number</u>
81	Sludge Flotation	SLUD	FLO	1
82	Aerobic Digestion	AERO	DIG	2
83	Anaerobic Digestion	ANAE	DIG	3
84	Gravity Thickening	GRAV	THC	4
85	Vacuum Filtration	VACU	FIL	5
86	Centrifugation	CENT	RIFU	6
87	Drying Beds	DRY	BEDS	7
88	Hauling and Land Filling	HAUL	GLF	62

Process Number	Unit Process Name	Process LISO	Name LISO2	ISW User Specified Cost Number
89	Multiple Hearth Incineration	MH I	NCIN	63
90	Fluidized Bed Incineration	FLUD	BED	64
91	Filter Press	FIL	PRES	65
92	Pressure Filtration	PRES	FIL	66
93	Wet Oxidation	WET	OXID	67
94	Sludge Drying Lagoons (Small)	SLUD	LAG	1
95	User Specified Process	USER	PRO	80

4-5 Labor Rates. The operation and maintenance labor rates are calculated from the user-specified (or default) OPERATOR II labor rate input. The operation man-hours are summed into SUMMH and the maintenance man-hours are summed into SUMOH. The OPERATOR Class II labor rate, variable SALOP, is then used to calculate the operation labor rate (SALO) and the maintenance labor rate (SALM) by the following equations.

$$SALM = 0.388 * SUMMH ** 0.85 * SALOP$$

$$SALO = 0.97 * SALOP$$

Administrative annual manpower and labor rates are calculated based on the average flow and OPERATOR Class II rate, respectively. Administrative annual man-hours (AMH) are calculated by the relationship

$$AMH = 348.7 * QAVE ** 0.7829$$

and the administrative labor rate (SALA) is calculated by the relationship

$$SALA = 20.02/AMH ** 0.3210 * SALOP$$

Laboratory annual manpower and labor rates are also based on average flow and the OPERATOR Class II labor rate. For average flows less than 20 mgd, the annual manpower (FLMH) is

$$FLMH = 2450.0 * QAVE ** 0.1515$$

and for average flows over 20 mgd

$$FLMH = 1062.0 * QAVE ** 0.4426$$

The labor rates for Laboratory personnel is calculated as being ten percent more than the OPERATOR Class II labor rate.

4-6 Cost Summary Output. The cost summary page provides a complete economic summary of the treatment train. The initial output consists of a schematic of the train by treatment process and modification number produced in subroutine PROCES. The cost summary table follows with a listing of each unit process in the train. For each unit process, the following cost items are presented:

- a) Initial total capital construction cost,
- b) Total construction cost including replacement with zero (0.0) inflation amortized over the design life of the plant,
- c) Annual operation labor cost,
- d) Annual maintenance labor cost,
- e) Annual cost of electricity,
- f) Annual material cost,
- g) Annual chemical cost, and
- h) Total annual operation and maintenance cost (sum of items (c) through (g))

The direct costs are output immediately after the cost summary table. Profit and overhead is calculated as a percentage of the total capital cost of the train. The other user-specified (see section 2-10 items 29 through 40) direct costs are either calculated from MCD-37 or are user-specified. The direct costs are summed and then added to the total capital cost of the train to provide the Total Construction Cost (SUMCCT).

Indirect cost items are listed next (see section 2-10 items 22 through 26 and item 28). Each of the indirect costs are calculated as a percentage of Total Construction Cost. In addition to those six indirect cost items, the A/E design fee (PENG) percentage is calculated from the ASCE curve based on Total Construction Cost in millions of dollars. The range of PENG is from 11.63 percent to 5.60 percent of the Total Construction Cost.

Following the indirect cost items, the land cost (ILAND), administrative cost (COSTA), and Laboratory cost (COSTL) are output.

The final economic costs of the train are output following the land, administrative, and laboratory costs. The Capital Cost (SUMC) is the sum of the Total Construction Cost (SUMC + DIRCOS), the indirect costs (INDSUM), and land costs (ILAND). The total operation and maintenance costs (SUMO) is the sum of the annual labor costs, electricity costs, material costs, and chemical costs. The equivalent annual cost (SUMA) is the sum of the total annual O & M costs (SUMO), the amortized construction costs (SUMAMR), the amortized sum of the direct and indirect costs, and the time value of the land (to be salvaged at cost ILAND at the end of the project life). The Present Worth of the train is the present worth of the equivalent annual cost (SUMA).

CHAPTER 5

SUBROUTINE BLOCKDATA

5-1 General. Subroutine BLOCKDATA provides the complete default data base for the unit process design specifications, influent waste characteristics, unit cost data, and the large and small system unit process data addresses. A general outline and example code will be provided for each of the sections of BLOCKDATA to illustrate the use of BLOCKDATA.

5-2 Unit Process Design Specifications. Labelled common BANKCO has 3,000 words of storage dimensioned in variable BANKDA in the executive routine CAPDET. In subroutine BLOCKDATA, the 79 unit processes are listed in labelled common BANKCO in the specific order that they are to be addressed in BANKDA and are dimensioned to the proper amount of data items as shown in the table of section 2-2. The pertinent code of subroutine BLOCKDATA is shown below.

```
COMMON/BANKCO/EQULDA (56), FLTD (24), FILTDA (81), MICRDA (22),  
>CARBDA (51), COUNDA (12), CROSDA (12), CIONDA (28), ALONDA (28),  
>  
>  
.  
.  
>ZOXIDD (36), ZLOAGD (27), 2ABARD (19), ZSEPTD (14), 2FACTID (24),  
>ZINTED (23), ZRAWSD (14), ZSLUDD (17), ZDRYID (18), PUMPDA (4), DUMMY (972)
```

It should be emphasized here that the particular order of the variables and size of the dimension of each variable is very important. The order and size of dimension is uniquely related to the address of labelled common ADDRCO which will be presented in section 5-5.

Each unit process data array is listed following BANKCO.

The order of the unit process arrays is not important, but the number of data items must be the same as the dimension with BANKCO and the order of the values must correspond to the EQUIVALENCE statement of the unit process input, execution, and output routines. For example, for the Equalization unit process, the DATA statement in subroutine BLOCKDATA is shown

```
DATA EQU LDA/24 * 0.0, 0.03, 0.9, 0.9, 5.0, 15.0, 0.0, 1.0, 30.0,
>2.0, 6.0, 0.0, 0.30, 20 * 0.0/
```

These 56 values of EQU LDA will be loaded into 56 addresses of BANKCO beginning with address 1 (see table of section 2-2). These 56 values correspond to the variables listed in the EQUIVALENCE table of the input, execution, and output routines for the Equalization unit process. The EQUIVALENCE table is shown below

```
DIMENSION FLOWS (24)
EQUIVALENCE (QQ(1), FLOWS(1)), (QQ(25), FMR), (QQ(26), ALPHA),
> (QQ(27), BETA ), (QQ(28), STE ), (QQ(29), OR ), (QQ(30), V ),
> (QQ(31), P ), (QQ(32), T ), (QQ(33), CL ), (QQ(34), D ),
> (QQ(35), KOSTSA), (QQ(36), KUPILL), (QQ(37), ITYP ), (QQ(38), FLOWA),
> (QQ(39), FL ), (QQ(40), VT ), (QQ(41), OTE ), (QQ(42), HP ),
> (QQ(43), DC ), (QQ(44), DF ), (QQ(45), VEW ), (QQ(46), SAL ),
> (QQ(47), VCW ), (QQ(48), VCS ), (QQ(49), K ), (QQ(50), HPT ),
> (QQ(51), HPS ), (QQ(52), FKWH ), (QQ(53), OMH ), (QQ(54), FMMH ),
> (QQ(55), OMMP ), (QQ(56), NF)
```

Therefore, the dimensioned variable FLOWS will be loaded with 24 zeroes (0.0), FMR with 0.03, ALPHA with 0.9, BETA with 0.9, STE with 5.0, and on to NF with a 0.0.

For any unit process which has an integer variable in its EQUIVALENCE list which is to be loaded with a nonzero value, the value in the unit process DATA statement should be a 0.0. Following the unit process DATA statement, the particular data item is EQUIVALENCED to an integer variable, and a DATA statement is used to load the desired integer value of the variable. For example, in the Post Aeration unit process, the seventh variable of the EQUIVALENCE list is the integer indicator of the type of aeration system used. The default value is desired to be a 1 for Diffused Aeration. The following sequence of code illustrates how that specification may be loaded correctly.

```
DATA POSTDA/2.0, 5.0, 10.0, 1.0, 30.0, 2.0, 0.0., 0.9, 0.9, 6.0,
> 0.8, 1.0, 26 * 0.0/
EQUIVALENCE (POSTDA(7), ITPO)
DATA ITPO/1/
```

Item 7

5-3 Influent Waste Characteristics. The 20 constituents of the waste influent stream have been described in section 2-9. The 20 constituents are stored in labelled common LIQUID and dimensioned variable LIQUIDA. In subroutine BLOCKDATA, the waste influent constituents are loaded as shown

```
COMMON/LIQUID/LIQUIDA (20)
DATA LIQUIDA/3 * 0.0, 18.0, 200.0, 60.0, 250.0, 75.0, 500.0, 400.00, 7.6,
> 160.0, 160.0, 45.0, 18.0, 25.0, 15.0, 80.0, 0.0, 0.0/
```

5-4 Unit Cost Data. The unit cost data are stored in labelled commons UNITCO and PERCCO. Reference should be made to section 2-10 for the unit cost variable name descriptions. The unit cost data are loaded in subroutine BLOCKDATA as shown below

```
COMMON/UNITCO/UPIBC, UPIEX, UPICW, UPICS, FMSECI, UPICR,
> EPACI, UPIR, FLABRI, SALOP, UPIPC, CHEM (4), ENRCCI, UPIHR, CEPCIP, FLABII,
> CCIPS, CCRS, COTS, CCPUS, UPILL
COMMON/PERCCO/FLAND, FMISC, PADM1, P201, PINSP, PCONT, PPROF, PTECH
> IFOUN, IEFPU, IEFDI, IEFOT, XL
> IMOB, ISITE, IELEC, IIAC, IMYRP, IPUMP, ILABM, IGRAY

DATA FLAND, FMISC, PADM1, P201, PINSP, PCONT, PPROF, PTECH
> IFOUN, IEFPU, IEFDI, IEFOT, XL, IMOB, ISITE, IELEC, IIAC, IMYRP, IPUMP,
> ILABM, IGRAY/
> 1000.00, 5.0, 2.0, 3.5, 2.0, 8.0, 22.0, 2.0, 4*0, 0.0, 8*0/
DATA UPIBC, UPIEX, UPICW, UPICS, FMSECI, UPICR,
> EPACI, UPIR, FLABRI, SALOP, UPIPC, CHEM, ENRCCI, UPIHR, CEPCIP, FLABII,
> CCIPS, CCRS, COTS, CCPUS, UPHILL/
> 48.0, 1.20, 207.0, 91.0, 577.0, 67.0, 163.00, 15.75, 13.40, 7.50, 0.04,
> 0.03, 0.04, 0.06, 1.62, 2886.0, 25.20, 295.2, 14.70, 3*0.0,
> 0.0, 1.0/
```

5-5 Large and Small System Unit Process Data Addresses. The design data for each unit process are loaded by the addresses listed in the variables LQADD (large liquid processes), LSADD (large sludge processes), LQADS (small liquid processes), and LSADS (small sludge processes) in labelled common ADDRCO. The addresses in BANKCO (BANKDA) are ordered sequentially by the unit processes as described in section 5-2. The beginning address of each unit process in BANKDA and its associated number of data items is referenced in sections 2-2 and 5-2.

It should be EMPHASIZED that these data are loaded for ONLY MODIFICATION ZERO of each unit process. Modifications one and two ARE NOT loaded with any default data. The code below provides an illustration of the loading of the unit process addresses in ADDRCO.

```
COMMON/ADDRCO/LQADD (80,3), LSADD (20,3), LQADS (80,3), LSADS (20,3)
DATA LQADD/1,57,81,162,184,235,247,259,287,315,322,331,366,402
> 438,474,510,546,583,1764,622,0,653,685,714,728,752,777,790,0,
> 1161,3*0,2025,1230,1253,1276,1299,1323,1357,1373,1400,183*0/
DATA LSADD/1438,1459,1484,1519,1536,1554,1570,1589,1602,
1616,1657,1668,1676,47*0/
DATA LQADS/1,1688,1721,4*0,842,2*0,1740,331,7*0,1764,1785,0,1833,
> 0,1869,728,0,1896,4*0,842,2*0,917,6*0,1030,1095,1161,1915,1929,
> 1953,1228,7*0,1976,183*0/
DATA LSADS/1990,5*0,2007,53*0/
```

CHAPTER 6
ADDING PROCESSES

6-1 General. The current structure of the CAPDET system allows for 80 liquid unit processes and for 20 sludge unit processes. Of these only 57 liquid processes and 14 sludge processes have been implemented. To add new large system processes to the system will require changes to the executive routine, to subroutine PROCES, subroutine BLOCKDATA, subroutine FIGURE, and to subroutine USERIN.

To add new small system processes, the executive routine, subroutine BLOCKDATA, subroutine SMALIN, subroutine SMALEX, subroutine FIGURE, and subroutine USERIN will be affected.

6-2 New Routine Addition. An input, an execution, and an output routine must be added to the system for the new unit process.

Skeleton coding for these routines is shown below.

```
SUBROUTINE NEWLIN (RR, ID, MODT)

  DIMENSION RR (1), KLM (74), VALUE (10), LIST (5)
  DIMENSION ID(3, 1)
  COMMON/QQCO/QQ(168)

  EQUIVALENCE (QQ(1), VAR1), (QQ(2), VAR2), (QQ(3), VAR3),
> (QQ(4), VAR4), (QQ(5), CAL1), (QQ(6), CAL2)

  DATA LIST/'NAME1', 'NAME2', 'NAME3', 'NAME4', 'END'/
  DATA IA/'I'/

101 FORMAT (A4, A2, 74A1)
951 FORMAT (' ', A4, A2, 74A1)
    CALL INIT (QQ, RR, 6)

50  READ (5, 101) KTYPE, LXX, KLM
    WRITE (6, 951) KTYPE, LXX, KLM
    CALL SCAN (NO, VALUE, 74, KLM)
```

```

DO 51 I = 1,5
IF (KTYPE.EQ. LIST (I) GO TO 53
51 CONTINUE
WRITE (6, 52) KTYPE
52 FORMAT ('0', A4, 2X' IS INVALID -CARD IGNORED')
GO TO 50
53 GO TO (1, 2, 3, 4, 5), I

```

```

1  VAR1 = VALUE (1)
   ID (MODT, 1) = IA
   GO TO 50
2  VAR2 = VALUE (1)
   ID (MODT, 2) = IA
   GO TO 50
3  VAR3 = VALUE (1)
   ID (MODT, 3) = IA
   GO TO 50
4  VAR4 = VALUE (1)
   ID (MODT, 4) = IA
   GO TO 50
5  CALL INIT (RR, QQ, 6)
   RETURN
   END

```

SUBROUTINE NEWLEX (RR)

DIMENSION RR (1)

COMMON ICTL, KCTL, IPRT, QMIN, QAVE, QMAX, TEMP, SOLIDS, VOLAT
>BOD5, BOD5S, COD, DODS, PH, CIC, CAC, TKN, PO4, FNH3, SETSO, OAG,
>ANO2, ANO3

COMMON/QQCO/qq (168)
EQUIVALENCE (qq(1), VAR1), (qq(2), VAR2), (qq(3), VAR3),
>(qq(4), VAR4), (qq(5), CAL1), (qq(6), CAL2)
CALL INIT (qq, RR, 6)

(first order design formulation
execution statements)

CAL1 =

(second and third order design and
cost formulation execution statements)

CAL2 =
CALL INIT (RR, QQ, 6)
RETURN
END

```

SUBROUTINE NEWLOT (RR, ID, MODT)
DIMENSION RR(1), ID(3, 1)
COMMON/STARCO/STARDA (19)
COMMON/QQCO/QQ(168)
EQUIVALENCE (QQ(1), VAR1), (QQ(2), VAR2), (QQ(3), VAR3),
>(QQ(4), VAR4), (QQ(5), VAR5), (QQ(6), VAR6)
CALL TITLE
WRITE (6, 120) STARDA
CALL INIT (QQ, RR, 6)

(first order design output statements)

IF (KCTL. EQ. 0) RETURN

(second order design output statements)

RETURN
END

```

6-3 Large System Unit Process Addition. For the addition of a new large system process, a number of changes will be required in the CAPDET executive routine. These changes will be referenced to a given FORTRAN statement number plus some number of statements. Statement number 000 will be assumed to occur just before the first executable statement of the particular routine (line 22 of the May 31, 1980 version of the CAPDET executive routine which has 22 COMMENT statements). Continuation lines will be considered to be part of one statement and not a new statement number.

In statement 000 + 002 of the executive routine, add one to the dimensions of either the liquid or sludge unit process and the liquid or sludge treatment process keyword arrays. The affected variables are as follows

- LISQ - Liquid Unit Process Keyword List
- LISS - Sludge Unit Process Keyword List
- LISTPL - Liquid Treatment Process Keyword List
- LISTPS - Sludge Treatment Process Keyword List

In statement 000 + 003, the DIMENSION statement for the variable ID should be increased for the number of default-input indicators added to the new 'OT' routine. For example if four input variables are to be output, the ID column count should be increased by four. The ID row count should remain unchanged at three.

In statement 000 + 009, the variables NOQ or NOS, the liquid unit process or sludge unit process data item count, should be increased by one, dependent on whether the new unit process is a liquid process or a sludge process.

In statement 000 + 031, the DATA statement for the variable ID should be changed to reflect the total number of default-input indicators added to the new 'OT' routine. For example, if four input variables are to be output, the DATA statement count should be increased by 12 (four data items times three modifications).

In statement 000 + 034, the DATA statement for the variable NEXTAD should be increased by the number of total data items to be stored in BANKDA. For example, if the new process will require six data items as shown in the skeletal routines outlined previously, six should be added to the current value of NEXTAD.

In statement 000 + 035, or statement 000 + 036, the number of data items for the unit process should be added to the end of the DATA statement for the variables NOQ or NOS dependent on whether the unit process is a liquid line or sludge line process. For example, if the new process is a liquid line process and has six data items, a six should be added to the end of the NOQ DATA list.

In statements 000 + 041 or statement 000 + 042, the four-character unit process keyword should be added to the end of the DATA statement for the variable LISQ (liquid) or LISS (sludge). For example, if the new unit process is ozone disinfection, the keyword 'OZON' should be added to the end of the LISQ DATA list.

In statement 000 + 043 or statement 000 + 044, the four-character treatment process keyword should be added to the end of the DATA statement for the variable LISTPL (liquid) or LISTPS (sludge). For the ozone disinfection process then, the keyword 'OZON' should be added to the end of the LISTPL DATA list.

The unit process and treatment process counts should be changed next. In statements 8021 + 002, 8021 + 003, 8021 + 004, and 8021 + 005, the variables for the unit process and treatment process counts are as follows

8021 + 002 NOLIQ - Number of Liquid Unit Processes
8021 + 003 NOSLU - Number of Sludge Unit Processes
8021 + 004 NOPRS - Number of Sludge Treatment Processes
8021 + 005 NOPRL - Number of Liquid Treatment Processes

For the type of process being added (liquid or sludge), the two affected variables should be increased by one. For the ozone disinfection process, the variables NOLIQ and NOPRL should both be increased by one.

If the new unit process is a liquid process, at statement 602 + 001, an acceptable (unused) statement number should be added to the end of the computed GO TO statement. If, for example, the new liquid unit process input routine is to be added at statement number 860, an 860 should be added to the end of the computed GO TO statement.

If the new unit process is a sludge process, at statement 603 + 001, an acceptable (unused) statement number should be added to the end of the computed GO TO statement.

The subroutine CALL for the input ('IN') routine should be inserted at the end of the input routines (before statement 42 + 000). The code for the ozone disinfection input subroutine may be placed, for example, after statement 857 + 001, and will consist of the following

```
860 CALL OZONIN (BANKDA(XADD), ID(1, 445), MODT)
      GO TO 100
```

The column subscripts for the variable ID should be the beginning subscript for the routine as changed at statement number 000 + 002.

In subroutine BLOCKDATA, the addition of a new large system unit process will cause the following changes to be made.

At statement 000 + 009, a dimensioned variable should be added to the end of the COMMON/BANKCO/statement. The variable should be dimensioned to the size of the number of data items to be stored in BANKDA for the unit process. For example, if the new ozone disinfection routine has six data items, the variable OZONDA (6) should be added before the DUMMY variable. The DUMMY variable dimension should then be reduced by six. The DUMMY DATA statement at statement 000 + 020 should then be changed to reflect the additional data items in BANKDA. The variable DUMMY is simply a count of the unused space in BANKDA and should be reduced by the number of data items added, in this case six.

At statement number 000 + 014 or 000 + 015, the appropriate variable DATA statement should be changed. If the new unit process is a liquid process, at statement 000 + 014, the beginning address that the process data are stored in BANKDA should be inserted. The appropriate address number will be the old value of NEXTAD which was changed in the executive routine. The address number should be added before the final entry of the LQADD DATA list and the last entry XXX*0, where XXX is the variable filler number, should be reduced by one. In the case of a sludge unit process, at statement 000 + 015, the appropriate address number should be added and the variable filler number reduced by one.

The final change in subroutine BLOCKDATA would then be the addition of the actual default data. These data may be added anywhere after statement number 000 + 020, but most logically should be added immediately before the RETURN statement. The number of data items will correspond to the dimensioned variable added to the COMMON/ BANKCO/ statement. The order of the values will correspond to the order of the variables as listed in the EQUIVALENCE statements in the unit process 'EX', 'IN', and 'OT' routines. For the ozone disinfection routine, if the first four variables are input items and the last two variables will be calculated, the statement to be added might be

DATA OZONDA/1.0, 976.3, 12.0, 2.0, 2*0.0/

The user should be careful when integer variables are used in the EQUIVALENCE routine and any of these variables are to be defaulted to a nonzero value. In this case the particular value in the DATA statement should be 0.0 and an additional EQUIVALENCE statement and DATA statement added to the BLOCKDATA routine. For example, if the fourth item of OZONDA is an integer variable with a default value of 2, the following code should be added

```
DATA OZONDA/1.0, 976.3, 12.0, 0.0, 2*0.0/  
EQUIVALENCE (OZONDA(4), INTV) fourth data  
DATA INTV/2/ item
```

where INTV is some integer variable not duplicated in subroutine BLOCKDATA.

In subroutine PROCES, the addition of a new large system process will cause the following changes to be made. For a liquid line treatment process, at statement number 7325 + 000, an appropriate (unused) statement number should be added at the end of the computed GO TO statement. For a sludge process, the statement number should be added to the end of the computed GO TO statement at statement number 7001 + 000.

The appropriate subroutine CALL statements for the treatment process should be added immediately before statement number 36 + 000. The new statements should include the 'EX' and 'OT' routines for the new main unit process and the 'OT' routines for any other unit processes

which are associated with the main unit process. For a new liquid line treatment process the new code might be as follows

```
860 KADD = LQADD (XX, MODT)
    CALL OZONEX (BANKDA(KADD))
    IF (IPRT.EQ.1) CALL OZONOT (BANKDA(KADD), ID (1, 423), MODT)
    GO TO 100
```

where XX is the number of the unit process added to variable LQADD in subroutine BLOCKDATA. The number will be the value that the variable NOLIQ was increased to in the executive routine.

For a new sludge line process the new code might be as follows

```
860 KADD = LSADD (XX, MODT)
    IF (L.EQ.2) CALL AAAAEX (SV, SSS, SVS, BANKDA(KADD))
    IF (L.EQ.3) CALL AAAAEX (PV, PSS, PVS, BANKDA(KADD))
    IF (IPRT.EQ.1.AND.L.EQ.2) CALL AAAAOT (BANKDA(KADD),
>ID (1, XXX), MODT)
    IF (IPRT.EQ.1.AND.L.EQ.3) CALL AAAAOT (BANKDA(KADD),
>ID (1, XXX), MODT)
    GO TO 100
```

Where XX is the appropriate number of the unit process number added to the variable LSADD in subroutine BLOCKDATA. The number will be the value that the variable NOSLU was increased to in the executive routine.

XXX is the appropriate number of the address for the input-default indicator set in variable ID in the executive routine.

In subroutine USERIN, the addition of a new unit proces will cause the following changes. At statement number 000 + 0001 the variable LIST dimension should be increased by one. At statement number 000 + 005, a four-character keyword for the new unit process should be added to the end of the LIST DATA statement. For the ozone disinfection unit process, the keyword 'OZON' should be added.

At statement number 951 + 003, the terminal limit of the DO statement should be increased by one.

In subroutine FIGURE, several changes are necessitated by the addition of a new unit process. At statement numbers 000 + 001 and 000 + 002, for a liquid unit process the DIMENSION limits for variables LSTRQ, LISQ, and LISQ2 should be increased by one. For a sludge unit process, the variables LSTRS, LISS, and LISS2 should have their DIMENSION limits increased by one.

At statement number 000 + 011 (liquid process) or at statement number 000 + 012 (sludge process), the count on the final ' ' in the DATA statement should be increased by one dependent on whether the unit process is a liquid or sludge process.

At statement number 000 + 014, the variable ISW DATA statement will have to be changed. The first 80 values of ISW are the locations of the liquid unit process in the variable USERDA. The next 20 values of ISW are the locations of the sludge unit processes in USERDA. The order of the particular address locations are dependent on the

unit process number assigned to the unit process. For liquid processes, the location of the unit process data in USERDA should be added immediately before the zero filler data within the first 80 values of ISW. The zero filler value should then be decreased by one. For a sludge unit process, the location of the unit process data in USERDA should be added immediately before the last zero filler data of the DATA statement. The zero filler value should be decreased by one. For either a liquid or sludge line unit process, the location within the ISW data should correspond to the unit process number (variable FNUM stored in SUMMDA (I, 9) for the Ith unit process).

The four-character treatment process identifying keywords should be added next. For liquid line treatment process, the DATA statements for variables LISQ and LISQ2 should be changed. At statements $000 + 015$ and $000 + 018$, four-character keyword descriptors should be added at the end of the DATA statements. For ozone disinfection, the four-character keyword 'OZON' should be added to the DATA list LISQ and the keyword '_DIS' should be added to LISQ2. For a sludge line process, the four-character keywords should be added to the DATA statements for the variables LISS and LISS2 at statement numbers $000 + 016$ and $000 + 017$.

6-4 Small System Unit Process Addition. For adding a new small system unit process, many of the changes that would be required are the same as for the addition of a large system unit process. Each of these changes will be discussed and where the changes are the same as for the large system, they will be so indicated.

In the executive routine, the required changes as listed are the same as for the addition of a large system unit process.

Changes at
Statement Number

000 + 002
000 + 003
000 + 009
000 + 031
000 + 034
000 + 035 or 000 + 036
000 + 041 or 000 + 042
000 + 043 or 000 + 044 +
802 + 002 through 8021 ~~to~~ 005

These are the only changes required in the executive routine for the addition of a new small unit process.

In subroutine SMALIN, the following changes should be made. At statement number 000 + 001, the DIMENSION limit of the variable NOQ (for a liquid process) or the variable NOS (for a sludge process) should be increased by one. The number of data items to be stored in BANKDA for the new process should then be added to the appropriate variable. For liquid processes, at statement 000 + 003, the number should be added at the end of the DATA statement for variable NOQ. The sludge processes at statement number 000 + 001, the number is added at the end of the NOS DATA statement.

If the new process is a liquid process, at statement number 1003 + 001, an appropriate (unused) statement number should be added to the end of the computed GO TO statement. If the process is a sludge process, an acceptable (unused) statement number should be added to the end of the computed GO TO statement at statement number 1005 + 001.

The subroutine CALL for the input ('IN') routine should be inserted at the end of the liquid or sludge line input routine. For liquid processes, the subroutine CALL should be immediately before statement 1002 + 000 and should have the following form

```
360 CALL ZOZONI (BANKDA(KADD), ID(1, 423), MODT)
      GO TO 300
```

Sludge line processes should be added immediately before the RETURN statement (statement number 300 + 000) and should have the same general form as the liquid processes.

Subroutine BLOCKDATA will have to be changed very similarly to the changes outlined for new large system unit processes. The change at statement number 000 + 009 (COMMON/BANKCO/) will be the same as outlined previously. Again the user should remember to change the DIMENSION limits of the variable DUMMY at the end of the statement.

At statements 000 + 016 or 000 + 017, the appropriate variable DATA statement should be changed. For a liquid process at statement

000 + 016, the appropriate address number (old value of NEXTAD) should be added to the list and the zero-filler variable reduced by one. For a sludge process, at statement 000 + 017, the appropriate address number should be added and the variable zero-filler value reduced by one.

The default data for the unit process should be added next. The procedure will be the same as outlined for a large system unit process.

In subroutine SMALEX, several changes will be necessitated by the addition of a new small system unit process. For a liquid process, at statement number 1001 + 000, an appropriate (unused) statement number should be added at the end of the computed GO TO statement. For a sludge process, the unused statement number should be added at the end of the computed GO TO statement at statement number 1002 + 000.

The subroutine CALL statements for a small system liquid treatment process should be added immediately before statement number 1002 + 000. A new sludge process CALL statement should be added immediately before the RETURN (statement number 300 + 000) statement. The new code for a liquid process would be similar to the large system process code as follows

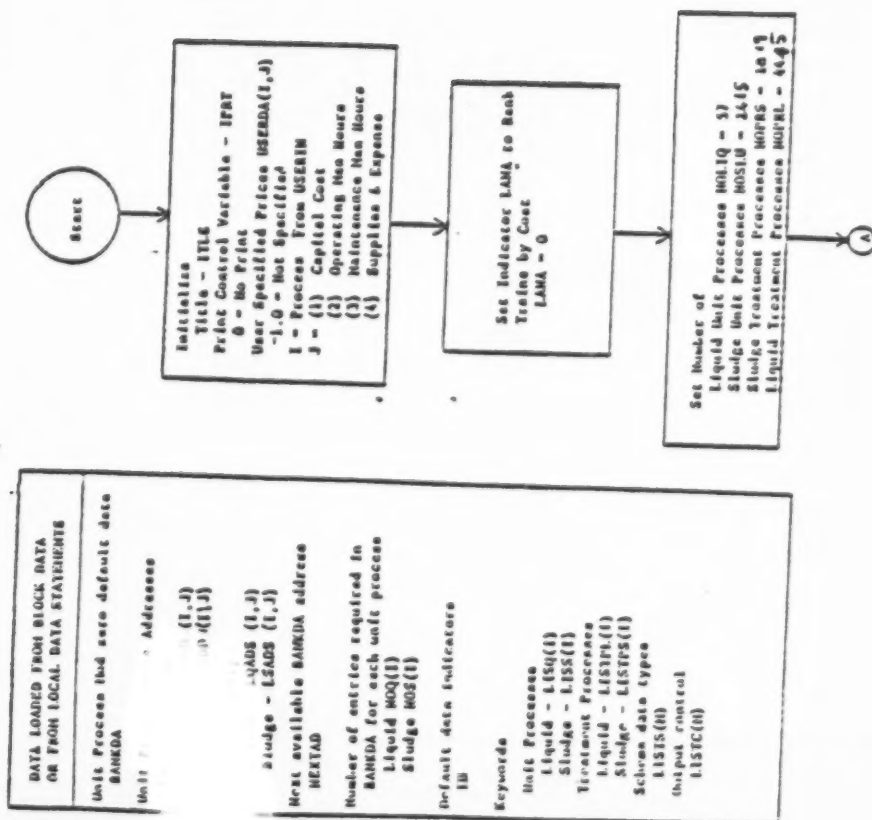
```
860  KADD = LQADS (XX, MODT)
      CALL ZOZONX (BANKDA(KADD))
      IF (IPRT. EQ. 1) CALL ZOZONO (BANKDA(KADD), ID (1, 445), MODT)
      GO TO 300
```

and for a sludge process

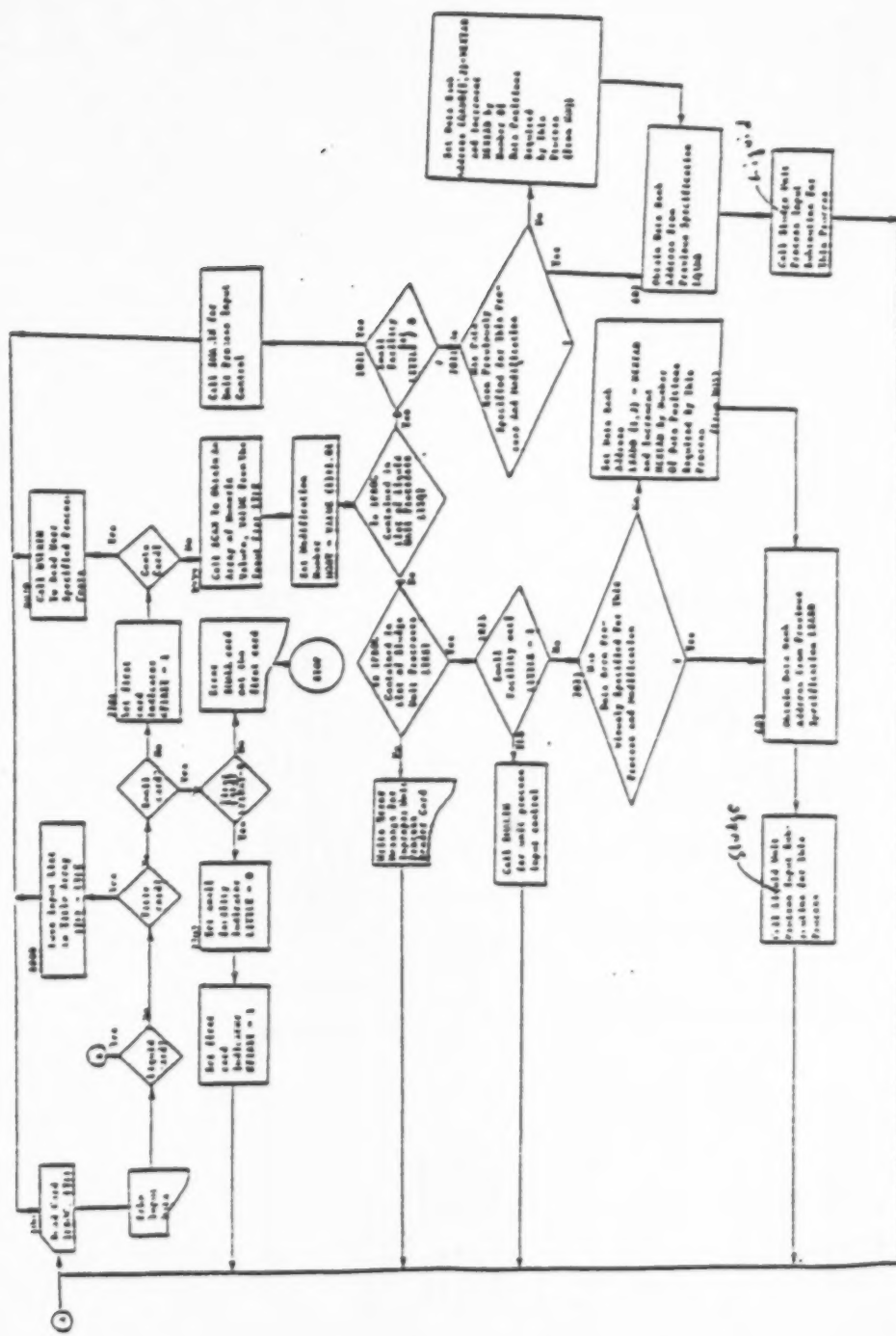
```
860  KADD = LSADS (XX, MODT)
      IF (L.EQ. 2) CALL ZAAAAX (SV, SSS, SVS, BANKDA(KADD))
      IF (L.EQ. 3) CALL ZAAAAX (PV, PSS, PVS, BANKDA(KADD))
      IF (IPRT.EQ. 1.AND. L.EQ. 2) CALL ZAAAAO (BANKDA(KADD),
>ID (1, XXX), MODT)
      IF (IPRT.EQ. 1.AND. L.EQ. 3) CALL ZAAAAO (BANKDA(KADD),
>ID(1, XXX), MODT)
```

Changes to subroutines USERIN and FIGURE would be accomplished in the same manner as outlined for large system unit process additions. No further reference will be made to these changes in this section.

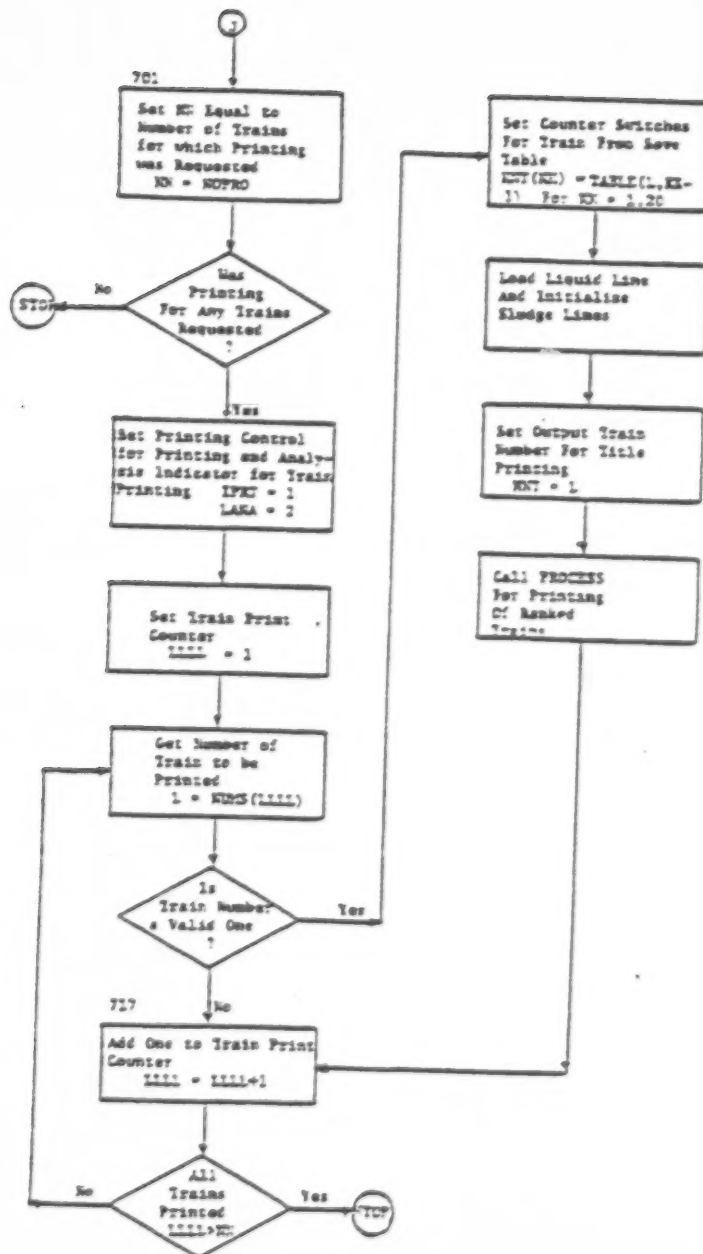
INITIALIZATION SECTION

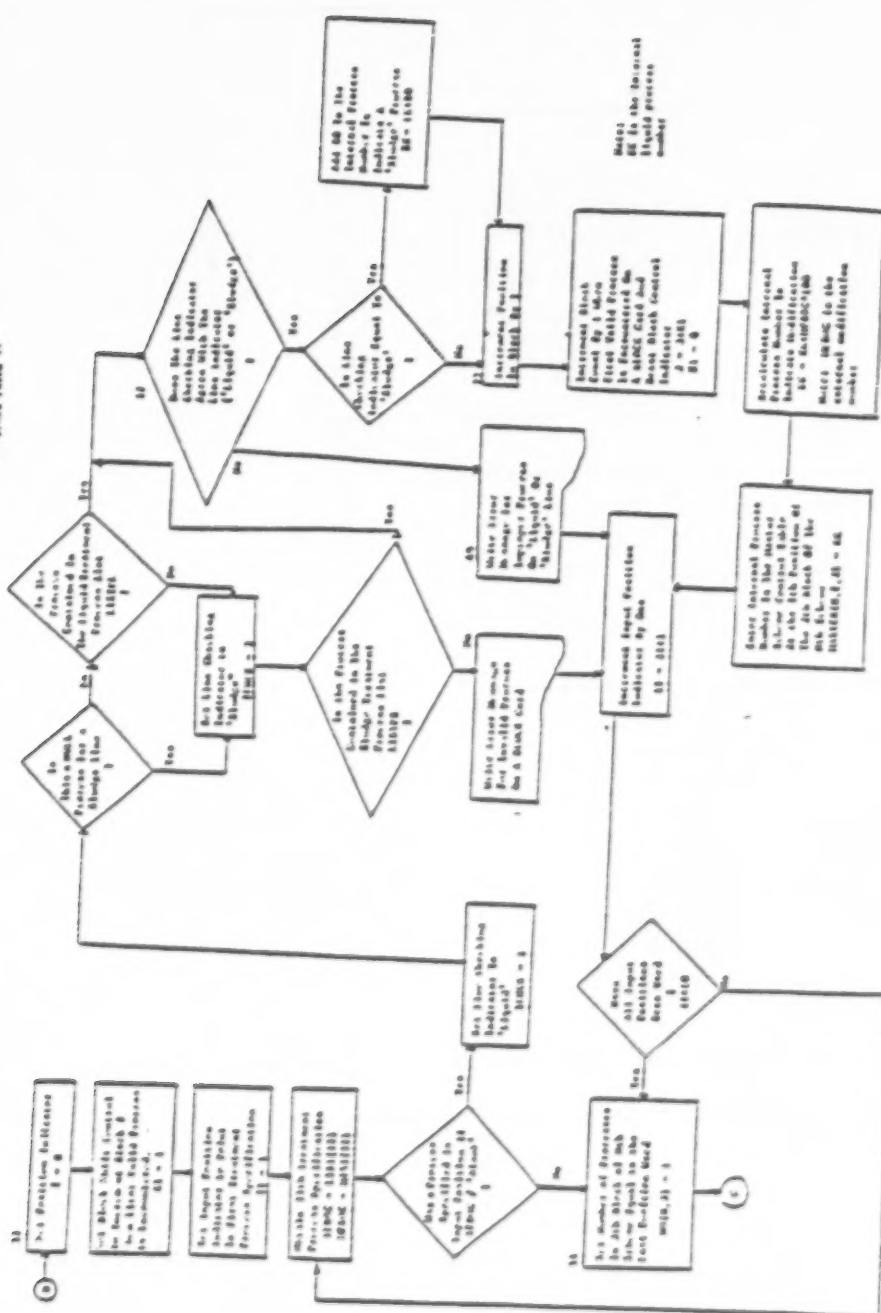


1

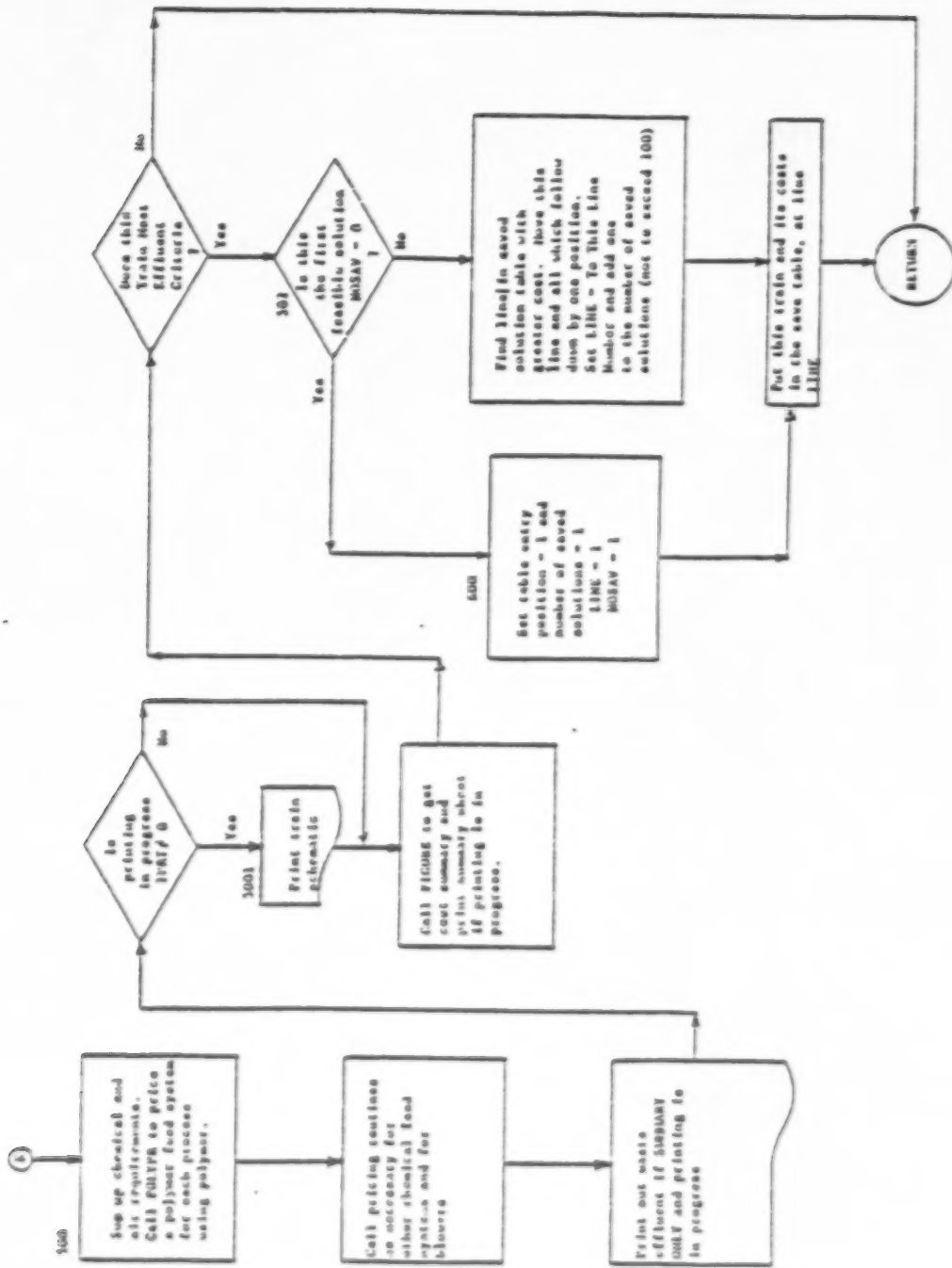


PRINT PROCESS OUTPUT SECTION

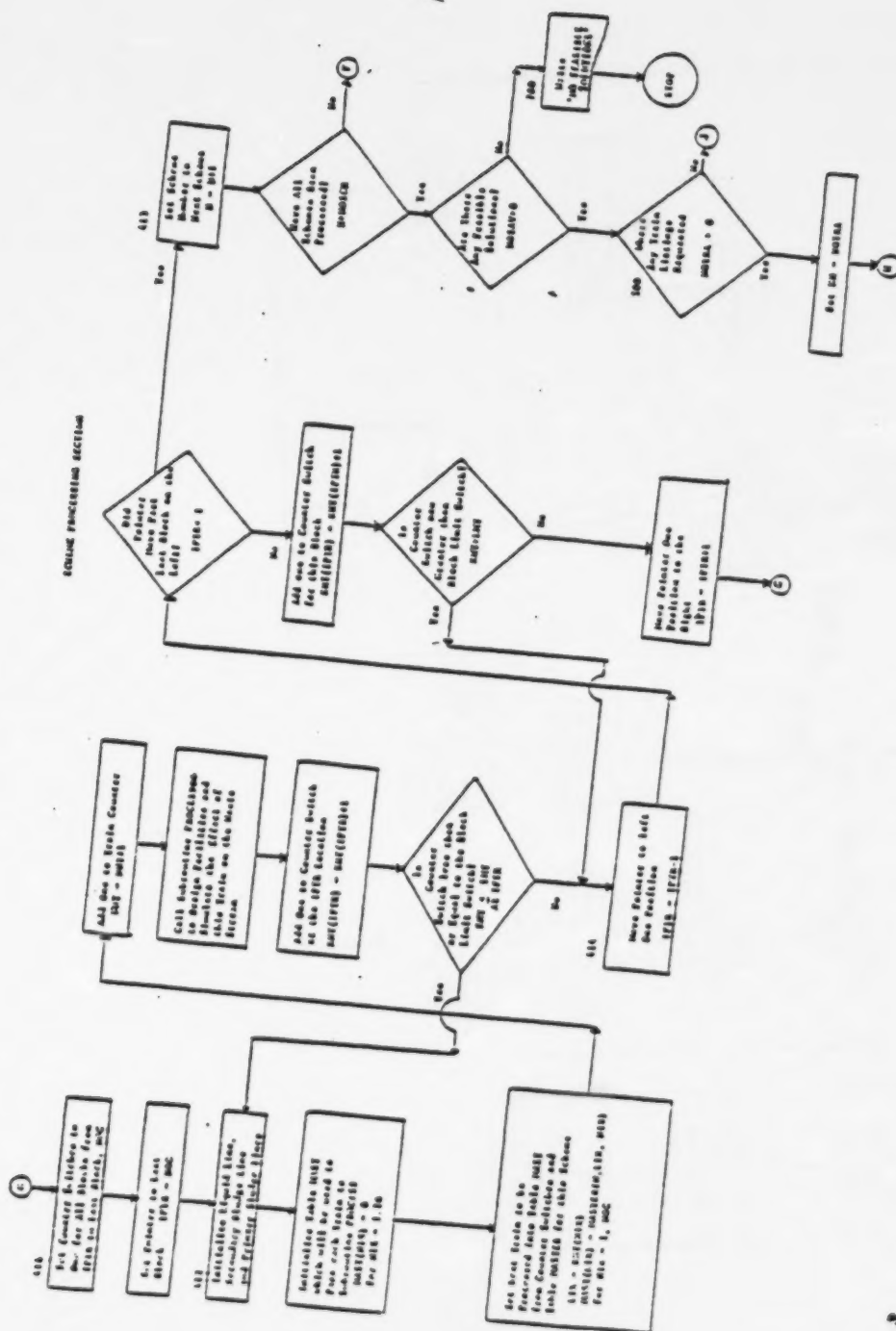


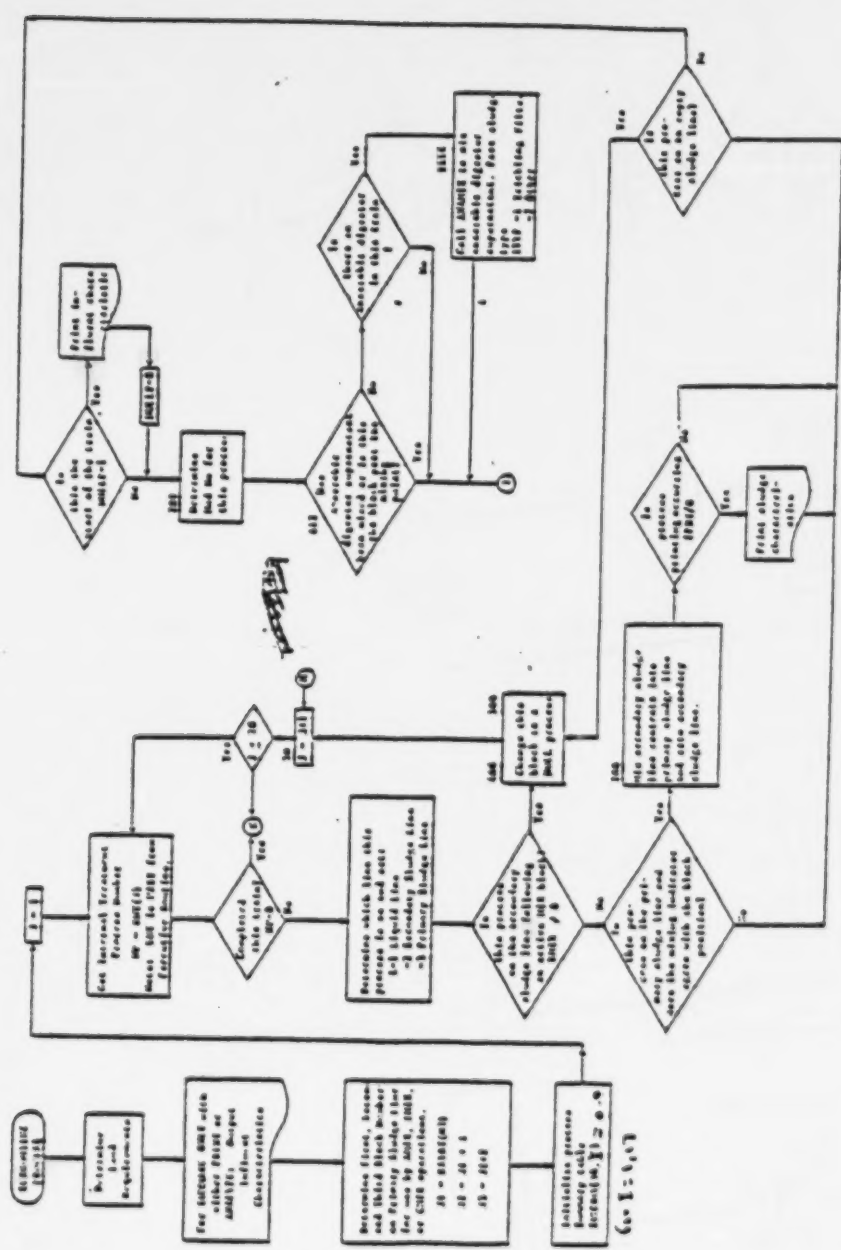


P3

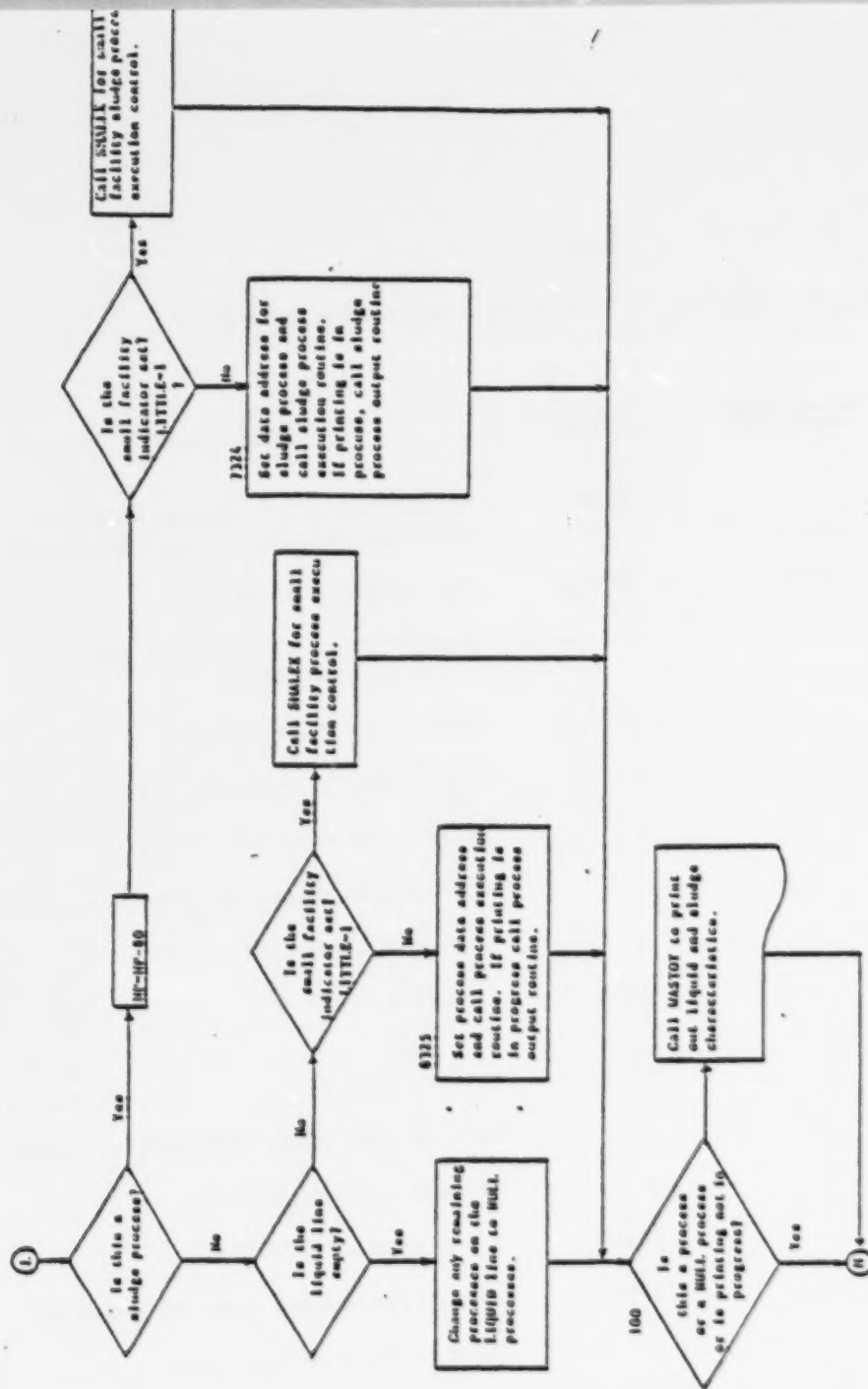








(P2)



APPENDIX C

Glossary of Variables in the Executive Routine (CAPDET)

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
AMRCOS		\$/yr	Total equivalent annual cost of the unit process under consideration.
BANKDA	3000	Varies	Unit process data base.
CAPCOS		\$	Capital cost of the unit process under consideration.
CCIPS		\$/ft.	Eight inch pipe costs.
CCPUS		\$	Eight inch pipe valve cost.
CCRS		\$	Eight inch pipe bend cost.
CEPCIC			Chemical Engineering Pipe Cost Index.
CHEM	4		Chemical Costs for:
		\$/lb	1. Lime
		\$/lb	2. Alum
		\$/lb	3. Iron
		\$/lb	4. Polymer
COSTS3	3	\$	Cost of the three standard blowers.
COST22		\$	Capital cost of a train.
COST23		\$/yr	O & M cost of a train
COST24		\$/yr	Equivalent annual cost of a train.
COTS		\$	Eight inch pipe tee cost.
DESIDA	20	Varies	Desired effluent characteristics. (Same description fas for LIQUDA)
DIVSOR			First quarter 1977 EPA index.

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
EFDI		\$	User specified cost of effluent diffusers.
EFOT		\$	User specified cost of effluent outfalls.
EFPU		\$	User specified costs of effluent pumping equipment.
ELEC		\$	User specified costs of site electrical.
ENRCCI			Engineering News Record Construction Cost index.
EPACI			EPA Construction Index.
FIAC		\$	User specified instrumentation and control cost.
FLABII		\$/hr	Pipe installation labor rate.
FLABM		\$	User specified Lab, Admin, and Maintenance Building Cost.
FLABRI		\$/hr	Construction labor rate.
FLAND		\$/acre	Land costs.
FMOB		\$	User specified cost for mobilization.
FMSECI			Marshall and Swift equipment cost index.
FMYRP		\$	User specified cost for yard piping.
FOUN		\$	User specified cost for special foundations.
GRAV		\$	User specified cost for gravity outfalls.
I			Loop index. Also treatment process position during BLOCK card de-coding.
IB	13		Array used by subroutine MONEY for formatting cost output with commas.
IBLK		Alpha	Blank comparator or data variable used to initialize the title.

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
ICHCK			ICHCK = 1 Process is a liquid process. ICHCK = 2 Process is a sludge process.
ICTL			Not used.
ID	445 3, ~~422~~		Default/Input indicators. Set initially to 'D's and changed to 'I' for input items.
IEFDI			Effluent Diffuser Cost Indicator. 0 = Not Requested 1 = Requested
IEFOT			Effluent Outfall Cost Indicator 0 = Not Requested 1 = Requested.
IEFPU			Effluent Pumping Cost Indicator 0 = Not Requested 1 = Requested.
IELEC			Site Electrical Cost Indicator 0 = Not Requested 1 = Requested.
IFOUN			Special Foundation Cost Indicator 0 = Not Requested 1 = Requested
IGRAV			Gravity Outfall Cost Indicator 0 = Not Requested 1 = Requested
II			Loop index used during BLOCK card de-coding.
ILAC			Instrumentation and control cost indicator. 0 = Not Requested 1 = Requested.
ILABM			Lab, Admin and Maintenance Building Cost Indicator 0 = Not Requested 1 = Requested

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
IMOB			Mobilization Cost Indicator 0 = Not Requested 1 = Requested
IMYRP			Yard Piping Cost Indicator 0 = Not Requested 1 = Requested
IPROC			Keyword from an input record. Also treatment process keyword on Block Card.
IPRT			Print control indicator. 0 = Printing not in progress 1 = Printing in progress.
IPTR			Number of the block where a treatment process is being changed in the train. Number of the odometer cog being ro- tated.
IPUMP			Raw waste pumping cost indicator. 0 = Not Requested 1 = Requested
ISITE			Site Electrical Cost Indicator 0 = Not Requested 1 = Requested
ISMAL			Keyword for SMALL FACILITY card.
ISSO			Summary Only indicator 0 = Not Requested 1 = Requested.
ITLE	66	Alpha	Title data.
IXXX		Alpha	Alphabetic characters from columns 5 and 6 of an input record.
IYYY		Alpha	Alphabetic characters from columns 7 through 10 of a treatment scheme input record.
IZZZ	10	Alpha	Alphabetic characters from the 5th and 6th position of each treatment process specification on a BLOCK card.

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
J			Block number under consideration.
KAB22	13	\$	Capital cost formatted with commas. From subroutine MONEY.
KAB23	13	\$/yr	O & M cost formatted with commas. From subroutine MONEY.
KAB24	13	\$/yr	Equivalent annual cost formatted with commas. From subroutine MONEY.
KADD			Address in BANKDA of the data for the unit process.
KB			Number of the BLOCK at which the line under consideration begins.
KCTL			OUTPUT, QUANTITIES indicator. 0 = Not Requested. 1 = Requested.
KE			Number of the BLOCK at which the line under consideration ends.
KEND	4,3		Contains the ending BLOCK number of each of the three lines for the four schemes.
KFIRST			First card indicator 0 = No input read yet. 1 = First card has been read.
KIST	4	Alpha	Alphabetic representation of modification numbers. Use to interpret mod numbers from BLOCK cards.
KK			Encoded process and modification number. Also loop index.
KLM	74	Alpha	Characters from columns 7-80 of an input record.

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>								
KNT	20		Treatment process position number in MASTER for each BLOCK of this train. The number of the face of cog on the odometer. Used to load the treatment process numbers into the train table MAST during the ANALYZE pass. Also the treatment process numbers of the train during the PRINT pass.								
KOST		Alpha	Keyword for user specified costs.								
KSTRT	4,3		Contains the beginning BLOCK number of each of the three lines for the four schemes.								
KTLE		Alpha	Keyword for TITLE card.								
KTYPE		Alpha	Keyword on treatment scheme input record or a control card.								
K1			New BLOCK card indicator 1 = First process on BLOCK card 0 = Subsequent process on BLOCK card.								
L			Index on line under consideration <table><tr><td><u>L</u></td><td><u>Line</u></td></tr><tr><td>1</td><td>Liquid</td></tr><tr><td>2</td><td>Secondary Sludge</td></tr><tr><td>3</td><td>Primary Sludge</td></tr></table> Also used as an index on some other loops.	<u>L</u>	<u>Line</u>	1	Liquid	2	Secondary Sludge	3	Primary Sludge
<u>L</u>	<u>Line</u>										
1	Liquid										
2	Secondary Sludge										
3	Primary Sludge										
LANA			Control Variable 0 = Analysis not specified 1 = Analysis requested 2 = Use during PRINT call to subroutine PROCES.								

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
LIQUDA	20		LIQUDA(I) is the value of the Ith characteristic of the liquid line. I
		MGD	1 minimum flow
		MGD	2 average flow
		MGD	3 maximum flow
		DEGC	4 temperature
		MG/L	5 suspended solids
		% of SS	6 volatile solids
		MG/L	7 BOD
		MG/L	8 SBOD5
		MG/L	9 COD
		MG/L	10 SCOD
		MG/L	11 pH
			12 Cations
		MG/L	13 Anions
		MG/L	14 TKN
		MG/L	15 PO4
		MG/L	16 NH3
		MG/L	17 Settleable Solids
		MG/L	18 Oil and Grease
		MG/L	19 NO2
		MG/L	20 NO3
LISQ	37	Alpha	Keywords for liquid unit processes.
LISS	13	Alpha	Keywords for sludge unit processes.
LIST	10	Alpha	Treatment process keywords from BLOCK cards.
LISTC	6	Alpha	Keywords for control cards.
LISTPL	44	Alpha	Keywords for liquid treatment processes.
LISTPS	17	Alpha	Keywords for sludge treatment processes.
LISTRA	20	Alpha	Output representations of treatment process in train under consideration.
LISTS	5	Alpha	Keywords for treatment scheme input.

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
LITTLE			Small facility indicator 0 = large facility 1 = small facility.
LIX			Treatment process number.
LL			Loop index.
LLLL			Loop index for PRINT pass.
LMT	20		Contains the number of processes in the BLOCKs of the scheme being processed.
LN			Block position on the particular line; liquid, secondary, sludge, or primary sludge line.
LQADD	80,3		Large facility liquid unit process data addresses in BANKDA.
LQADS	80,3		Small facility liquid unit process data addresses in BANKDA.
LSADD	20,3		Large facility sludge unit process data address in BANKDA.
LSADS	20,3		Small facility sludge unit process data address in BANKDA.
LITLE	66	Alpha	Alphabetic characters from columns 7 through 72 of an input record.
MAST	20		Treatment process numbers of the train being processed.
MASTER	4,10,20		Scheme description consisting of treatment process numbers for 4 schemes, 20 blocks per scheme and 10 treatment processes per block.
MIST	20		List of the modification numbers from the BLOCK card input. Numeric form.

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
MISTRA	20		Output representation of the modification numbers of the treatment processes in the train under consideration.
MODT			Process modification number.
MPROC			Modification number used in de-coding BLOCK cards.
N			Scheme number under consideration.
NEXTAD			Indicates first unused location in BANKDA.
NIST	10	Alpha	Alphabetic form of modification numbers from BLOCK cards.
NIX			Loop index used in initializing the limit switches LMT and in establishing the trains.
NN			Number of numeric values found on an input record by subroutine SCAN. Also number of trains to be listed.
NNT			Train number being processed. Unranked during ANALYSIS pass. Ranked during PRINT pass.
NO	4,20		Number of treatment processes in the twenty BLOCKS of each of the four schemes.
NOC			Number of BLOCKS on the scheme under consideration.
NOLIQ			Number of liquid unit processes.
NOPER		Years	Number of years from the GO card.
NOPRL			Number of liquid treatment processes.

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
NOPRO			Number of trains to be printed under the PRINT option.
NOPRS			Number of sludge treatment processes.
NOQ	57		Number of data items in BANKDA for the large facility liquid processes.
NOS	13		Number of data items in BANKDA for the large facility sludge processes.
NOSAV			Number of trains saved in TABLE.
NOSCH			Number of specified schemes.
NOSLU			Number of sludge unit processes.
NOTRA			Number of trains to be listed under the LIST option.
NP			Treatment process number.
NUM			
NUMS	25		Numbers of the trains to be printed under the PRINT option.
OPMCOS		\$/yr.	Operating and maintenance cost.
PADMI		Percent	Administrative Cost.
PCONT		Percent	Contingencies Cost.
PINSP		Percent	Inspection Cost.
PMISC		Percent	Miscellaneous Cost.
PPROF		Percent	Profit and Overhead.
PSLUDA	3	gal/day Percent Percent	Primary sludge line characteristics. 1. Sludge volume 2. Percent solids 3. Percent volatile solids

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
PTECH		Percent	Technical Costs
PUMP		\$	User specified cost for raw waste pumping.
P201		Percent	201 Costs
QQ	168	Varies	Array used for EQUIVALENCE of variable names.
RATE		Percent	Interest rate from the GO card.
RBCALK		mg/l	Input alkalinity to the nitrification RBC process.
RBCREQ		mg/l	Alkalinity required by the nitrification RBC process.
SALOP		\$/hr	Class II operator salary.
SITE		\$	User specified site electrical cost.
SSLUDA	3		Secondary sludge line characteristics.
		gal/day	1. Sludge volume
		Percent	2. Percent solids
		Percent	3. Percent volatile solids.
STARDA	19	Alpha	Output separator data.
SUMMDA	30,17		One entry for each of 30 processes.
		\$	1. Construction cost
		man-hr/yr	2. Operating manpower
		man-hr/yr	3. Maintenance manpower
		kwhr/yr	4. Electricity
		yr	6. O & M supply costs
		\$/yr	7. Air requirement
		Scfm	8. Cost indicator
			9. Process number
		lb/day	10. Daily lime requirement
		lb/day	11. Daily alum requirement
		lb/day	12. Daily iron salt requirement
		lb/day	13. Daily polymer requirement
		lb/year	14. Annual lime requirement
		lb/year	15. Annual alum requirement
		lb/year	16. Annual iron salts requirement
		lb/year	17. Annual polymer requirement

<u>Variable</u>	<u>Dimension</u>	<u>Units</u>	<u>Definition</u>
TABLE	100,24		Contains data to rank and store 100 trains. 1- Scheme number 2-21 Treatment process numbers \$ 22- Capital cost \$/yr. 23- O & M Cost \$/yr. 24- Equivalent Annual Cost
TRFALK		mg/l	Input alkalinity for the nitrification trickling filter process.
TRFREQ		mg/l	Required alkalinity for the nitrification trickling filter process.
UPLBC		\$/sq.ft.	Unit cost for buildings.
UPICR		\$/hr.	Unit cost for crane rental.
UPICS		\$/cu.yd.	Unit cost for slab concrete.
UPICW		\$/cu.yd.	Unit cost for wall concrete.
UPIEX		\$/cu.yd.	Unit cost for excavation.
UPIHR		\$/ft.	Unit costs for handrails.
UPILL			Not used.
UPIPC		\$/Kwhr	Power cost.
UPIR		\$/sq.ft.	Unit price for canopy roofs.
USE	20	Varies	Liquid line constituents. Referred to as an array for easy transfer from LIQUDA.
USERDA	100,4	\$ man-hr/yr man-hr/yr \$/yr	User supplied costs. 1 - Capital costs 2 - Operating labor 3 - Maintenance labor 4 - supply costs A - 1.0 indicates cost was not supplied.